CHEMICAL SOCIETIES AND THEIR JOURNALS: WHAT CAN BE LEARNED ABOUT THE STATE OF CHEMISTRY FROM AN ANALYSIS OF THE FIRST VOLUMES OF THESE JOURNALS

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Introduction

What can we learn from the founding of chemical societies in the nineteenth century and an analysis of the first volumes of their journals as to the state of chemistry? Are these specific national phenomena or are there certain factors in common? Did chemical societies form because of a perceived need at the time of their founding or was it perhaps that a certain critical mass had been reached that led to the founding of the societies? What were the purposes set out by these societies for their journals? What influence did these journals have on the development of chemistry in their own country and for the chemical communities as a whole? These are a few of the questions that will be addressed in his paper. The societies that were analyzed are *The Chemical Society of London (1841), The German Chemical Society in Berlin (1867), and the American Chemical Society (1876)***.**

The Chemical Society of London

In England the Royal Society had existed since 1660 (1), but because of the increasing specialization taking place in the natural sciences, specialist societies began to develop in the late eighteenth century. The first was the Linnaean Society of London (1778), and early in the nineteenth century in a relatively short time frame were founded the Geological Society of London (1807), Zoological Society of London (1826), Royal Astronomical Society (1831), and the Chemical Society of London (1841). The Chemical Society of London is the oldest continuous chemical society in the world. In 1972 it merged with the Royal Institute of Chemistry, The Faraday Society, and the Society for Analytical Chemistry to form the Royal Society of Chemistry.

The most important influences on the development of British chemistry in the early nineteenth century were mainly external. British chemistry was influenced by the development occurring in Germany where new techniques of analysis and training were being developed by Justus Liebig at Giessen and Friedrich Wöhler at Göttingen. Of the two there is little doubt that the more important figure in shaping British chemistry was Justus Liebig (2). Bud and Roberts have remarked that (3):

> He was a persuasive propagandist too, arguing both in Germany and abroad for the multiple utilities of chemistry. The aggressive and charismatic Liebig came to symbolize the powerful chemist to generations of chemists.

Liebig's emphasis on learning by doing in the laboratory served as an incentive for students from Britain as well as from other countries to come to Giessen. Among the contributors to the first volume of the *Quarterly Journal* here were seven who had Giessen connections. The most notable were the government chemist Lyon Playfair and the alkali manufacturer Sheridan Muspratt. By 1841

in Britain there existed a community of academic and professional chemists who saw the need for a society to serve all types of chemists. Thus the founding of The Chemical Society was a very practical one, whereas later societies, as we will show, had much loftier and idealistic aims.

Robert Warrington (1807-1867) was the guiding force in the call for the formation of a chemical society based in London. A chemist (pharmacist) by training, he had held positions as a brewery chemist, chemical operator for the Society of Apothecaries, and author of the first edition of the British Pharmacopoeia. He served as secretary of The Chemical Society from its founding until 1851. On the occasion of the jubilee of The Chemical Society Warrington's son recalled the following (4):

> There are two circumstances which helped to determine the formation of the Chemical Society in 1841. The preceding year had seen the commencement of the penny postage, and this fact undoubtedly gave an impetus to all attempts at organization requiring much correspondence. The year 1841 was also a short period of leisure in the life of my father. Between 1839 and 1842 he held no official position, and was at liberty to turn his energies in any direction which he might desire.

Warrington shrewdly enlisted the support of a cross-section of the leading academics, chemical manufacturers, and consulting chemists in London. These included the academics Thomas Graham and William Braude, the manufacturer Warren de la Rue, and the consulting chemist Lyon Playfair among others (5). The organizational meeting took place on February 23, 1841, and twenty-five were in attendance. Thomas Graham of University College was elected the first president of the society.

The first scientific meeting was held on April 13, 1841 and, quite appropriately, the first paper read was a translation of Liebig's concerning "The Yellow Prussiate Potash." By the end of its first year in existence the Chemical Society had a membership of 77; this doubled by 1844 and tripled by 1848. By its jubilee in 1891 membership had risen to 1,754 members.

The program proposed by Warrington for the Chemical Society at its organization was (6):

> The reading of notes and papers on chemical science …and the discussion of the same. The formation of a laboratory, in which might be carried out the more abstruse and disputed points connected with the science. The establishment of a collection of standard chemical preparations, of as varied a nature as possible, for reference and comparison, and thus to supply a very great desideratum in a metropolis; the formation of a library, to include particularly the works and publications of Continental authors.

Only the first part of this program was ever to be realized.

As the society grew in the 1840s, the London academics became the dominant force in the Chemical Society. The charter stated that the goal of the Society was the advancement of chemistry as a way of assuring the prosperity of the manufacturing sector, a most laudable goal. This goal was quickly abandoned as the basic science became much more of a paramount interest than the practice of chemistry. This tension between science and practice would lead to the founding of the Institute of Chemists in 1877 and the Society of Chemical Industry in 1881 to represent the interests of the industry. These moves transformed the Chemical Society into an organization whose main goal was the advancement of the science.

The founding of the Chemical Society was a response to internal factors operating in Britain. There were no external influences such as other chemical societies pushing for the founding; if anything the reverse would be true as the Chemical Society would become the model for most of the chemical societies of the world.

Initially papers read at the Chemical Society meetings were published in the *Memoirs and Transactions of the Chemical Society*, which appeared at sporadic intervals. In March of 1848 William Thomas Brande, in his Presidential Address, made the following statement (7):

> At the last Anniversary Meeting, your Council was requested to consider any and what means could be devised for the purpose of ensuring a more regular and efficient publication of the Society's Memoirs, and it has accordingly been determined, in order to promote the more speedy and regular circulation of the communications made to the Society, amongst its Members, to publish the Memoirs and Proceedings…in the form of a *Quarterly Journal*

All issues of the *Journal* were also to include abstracts of important foreign papers ensuring that the publication would be of greater value to its readers. Thus subscribers would be able to keep up with what was happening on the continent if they did not have access to a library or could not afford the costs of subscribing to journals like Liebig's *Annalen der Chemie und Pharmacie*, for example. The January number for each year was to include an alphabetical list of all the domestic and foreign papers that appeared during the year. A publications commit-

tee decided what would be in the journal and picked the editor as well. The first editor was Edmund Ronalds, a Geissen-trained (D. Phil. 1842) chemist working in London. Ronalds left his position as editor after two years and was succeeded by Henry Watts (8), who held the position from 1849 until his death in 1884. This was a salaried position and involved the day-to-day activities of the *Journal*. The real power lay in the publications committee, and thus Watts' name as editor is not included along with the committee members' names that appear in each issue.

The first volume of the *Quarterly Journal* consisted of a mix of translated abstracts of papers from foreign journals as well as original contributions from Society members. The foreign abstracts represented some of the most notable names in continental chemistry, Wöhler, Gay-Lussac, Gerhard, Laurent, Gmelin, and Liebig, among others. The first volume also contained 29 papers in many different subject areas by a diverse group of British authors. The analysis of this volume will be discussed latter.

One of the most significant figures in British chemistry at the time was the German organic chemist, August Hofmann. Hofmann, a student of Liebig, had come to London in 1845 to head the newly founded Royal College of Chemistry (9). His investigations concerning the composition of coal tar were instrumental in the development of the synthetic organic chemical industry. William Henry Perkin, a student at the Royal College of Chemistry, discovered the first synthetic dye mauve in 1856, which led to the preeminent position of the British organic chemical industry over the next several decades. Many of Hofmann's students worked in the dye industry, and German-trained chemists, with their superb training, came to work in British chemical industry because there were few opportunities at home. Strong chemical ties developed between Britain and Germany that were to last until 1914. One of the consequences of the British experience for German expatriates, when they returned home, was the founding of the Deutsche Chemische Gesellschaft zu Berlin in 1868.

Die Deutsche Chemische Gesellschaft zu Berlin (10)

At the jubilee celebration of the Chemical Society of London on February 24-25, 1891, Edward Frankland, in his toast to the "Delegates of Foreign Chemical Societies," made the following remarks (11):

> The Chemical Society of London whilst justly proud of the position as *alma mater* to all Chemical Societies of the world, can hardly claim to have exercised much parental care even during the infancy of her offspring. They did not require it.

In his remarks concerning the German chemical society, Frankland pointed out the pivotal role played by August Hofmann in its founding (11):

> I am not sure whether this exceedingly vigourous child was smuggled into Germany by our friend Hofmann, whose absence we so much deplore. At all events the circumstances are very suspicious. You know that Professor Hofmann is a past President of the parent Society. You know he left this country in the year 1865; that he was one of the most active of our Society during the twenty years he spent in London; and we first hear of the German Chemical Society in the following year, and he was the first President. Were he here now, we should make him confess.

Through Hofmann the idea of a national chemical society came to Germany. The founding of the German Chemical Society in Berlin in 1868 can be attributed to a confluence of events, perhaps most important of which was the return of Hofmann to Germany. Germany was becoming a unified country under Prussian leadership, rather than a patchwork of many competing states. The transformation from an agrarian to an industrial society was well under way by 1868. The synthetic organic chemical industry was still in its infancy, yet in a few decades Germany would dominate this field of manufacturing. This was in part due to the expertise of many expatriate German chemists, who had worked in England and later returned home (12). One important reason for their return was the modernization occurring in the German universities with respect to the natural sciences. Sufficient funds now became available to build teaching laboratories that had been lacking at many of the universities. Previously there were only a few private laboratories, and a small number of universities existed where basic research was being performed. Of the major universities in Prussia only Breslau, Greifswald, Königsberg, and Halle had such facilities in 1863. As early as 1859 the Prussian government approved the building of a chemical institute in the capital of Berlin, but construction did not begin until May, 1865. In 1863 Hofmann was offered the chair at this new institute in Berlin, but he was reluctant to leave England. The position included the opportunity to design the chemical institute to his liking, and this proved to be an offer he could not refuse.

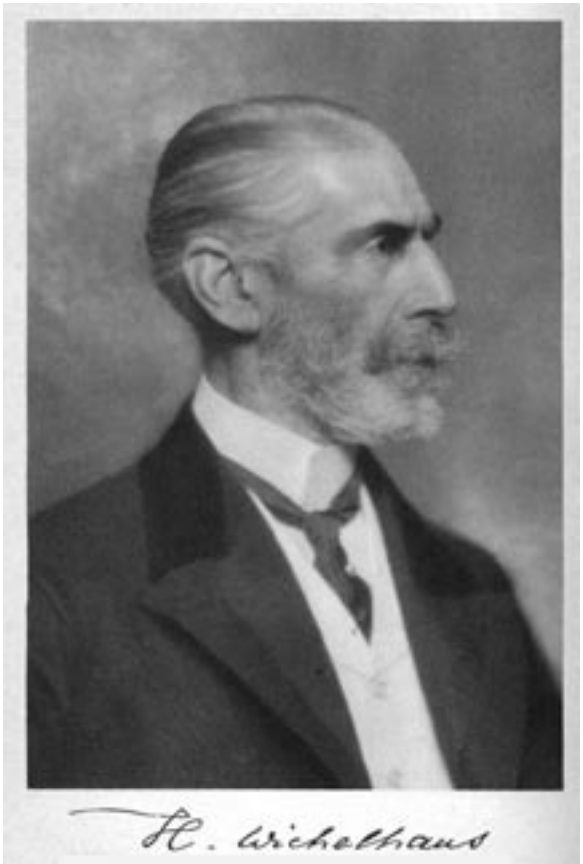
Hofmann brought his enthusiasm for research and also the realization that pure and applied chemistry were

intertwined. He had been instrumental in the development of the synthetic organic chemical industry in Britain and had acted as a consultant to many manufacturers. As an active member of the Chemical Society from his arrival in London in 1845, he was familiar with the organization as well as the benefits of establishing a similar society in Berlin. This new Berlin society was founded with the idea of eventually becoming a national chemical society (13). In the fall of 1867 Carl Martius (a student of Hofmann, who had followed him to Berlin) and Hermann Wichelhaus used the London model to formulate a set of statutes for the society. Adolf Baeyer and Carl Scheibler approved these and asked Hofmann to call an organizational meeting to be held on November 11, 1867. Hofmann wisely concluded that it would be better to have this invitation come from long established Berlin chemists since he was a relative newcomer in Berlin. The invitation to join this new society was signed by ten prominent Berlin chemists, and approximately 100 chemists attended the organizational meeting at the Commercial Museum. Adolf Baeyer chaired the meeting and pointed to the new chemical institute with its marvelous facilities for instruction as a good reason to found the society. The new institute, he believed, would be a magnet to draw the chemical community into a union "which would produce the richest fruits for the scientific as well as technical areas of chemistry"(13). Hofmann, asked to assume the provisional presidency for the organizational meeting, stated that (13, 14):

> …he believed he could assure numerous assembled colleagues that at some future date they would look back with satisfaction on this day of establishment of a chemical society at Berlin….he in no way doubted that just as glorious a future lay ahead for the society, for whose establishment a great majority of Berlin chemists had assembled this evening.

The formal establishment of the society took place on January 15, 1868 when a revised set of statutes was adopted and Hofmann was elected President—a position he held for 25 years. The Vice-Presidents were Adolph Baeyer, Carl Rammelsberg, Gustav Magnus, and Otto Barwald. The society had 95 members living in Berlin, 8 outside, and 3 honorary members (Bunsen, Liebig, and Wohler).

The founding of the DCG is an example of a combination of both the external factor of having the English society as a model and the internal factor of the rapid growth of the chemical industry and university facilities. Would the DCG have been founded much later than 1867 if Hofmann had not come to Berlin in 1865? Ruske in his history of the DCG touches on the question of Hofmann's motives by reference to opinions of Hofmann's contemporaries. Ferdinand Tiemann and Wilhelm Will were certain that it was patriotism and his love of the *Vaterland* that motivated Hofmann. In moving to Berlin he had assumed a lesser position than he had in Britain, and it was only his belief that he could do some good that motivated him. Gustav Magnus believed his motivation was the experience he had had with the English system of education and its emphasis on a practical approach. He was afraid that the evolving German educational system would emphasize the practice of chemistry to the detriment of theory. Magnus noted "the fire in the belly of a teacher of science" that motivated Hofmann. A professional chemical society that was German would elevate the more lofty goals of what he believed to be the goal of the chemist. Hofmann, having only recently come to Berlin, used his colleagues who were better known to begin the process of the formation of the society. Had it not been Hofmann there is little doubt that others would have instigated the creation of a German chemical society, given the rapid growth occurring in Germany, especially after unification in 1871.



First Editor of Berichte

The American Chemical Society (15)

The development of a national chemical society in the nineteenth century in the United States presented a unique set of challenges. Whereas London and Berlin were major centers of chemical activity, there was no similar comparable venue in the United States. Given the size of the country and the scarcity of significant opportunities for doing chemistry beyond the elementary level and the lack of opportunities for chemists, a national chemical society seemed a distant goal until well into the late 1870s. The only truly national body for chemists prior to the founding of the American Chemical Society was the American Association for the Advancement of Science (founded in 1848) and its Section A, which dealt with mathematics, physics, and chemistry. Section A and Section B dealing with natural history were the two original divisions from the founding of the AAAS. Within Section A there developed a sub-section of Chemistry and Mineralogy. By 1874 a Section C that dealt exclusively with chemistry had been authorized. The original subsection on chemistry and mineralogy within Section A had provided a very successful venue in terms of the presentation of papers from at least 1860 at the annual AAAS meetings. Most of the prominent American chemists of this era were members of the section and thus there seemed to be no pressing need for a national chemical society (16). Chemists had opportunities to publish their work in journals such as the *Proceedings of the American Association for the Advancement* of *Science* and *the American Journal of Science,* as well as in the journals of foreign chemical societies.

Hermann Endemann
Editor, JACS*, 1879, 1881*

In 1874 at the Priestley Centennial Meeting in Northumberland, Pennsylvania, a discussion was held among the 77 chemists present concerning the advisability of establishing a truly national chemical society. The consensus was that the time was not yet right and that the best way to proceed was to strengthen the AAAS chemical section. However, a group of chemists from the New York metropolitan area, under the leadership of C.F. Chandler of Columbia College, decided in January 1876 to organize a chemical society initially restricted to the New York area. A preliminary mailing of a prospectus to 100 chemists in the metropolitan New York area produced such a favorable response that it was decided by the organizers in March, 1876 to bypass the local society model and form a national society. Chandler's and his associates' belief that the response of the New York group represented a pent up demand for a national society proved to be wrong. The organizational meeting for the American Chemical Society was then held on April 6, 1876 and the Constitution and By-laws were read and approved (15). The society was incorporated under the laws of the State of New York in 1877, and all 13 directors had therefore to be residents of New York. That the national society was really a local society in disguise led to almost immediate problems in terms of its membership and finances. As C. A. Browne has written (15):

> Chemists outside of New York therefore looked upon the Society as a purely local organization and were unable to see that conditions for them were any better than before the Society's foundation…The non-resident membership…reached its maximum by the end of the first year.

Articles published in the *Journal* were reports that had been delivered initially at meetings of the American Chemical Society in New York. Consequently, the first issue of the *Journal of the American Chemical Society* in 1879 is not truly representative of the current state of American chemistry since many of the most important chemists in America were not members of the society, and therefore their work would have not been included. The founding of the American Chemical Society was the result of a set of internal circumstances which included a local critical mass of chemists in New York and the feeling that it was time for chemistry to identify itself as a unique scientific endeavor with its own voice. Perhaps the centennial of the founding of the United States in 1876 played some role in this. However, it was an external model, The Society of Chemical Industry of Great Britain, that rescued the American Chemical Society and made it into a truly national chemical society.

Those chemists dissatisfied with the New York-centered nature of the ACS urged the adoption of the English model in 1890. This led to the founding of local sections and national meetings that occurred in different venues so that more members would be able to attend them. This led to a rejuvenation of the society and its future success.

A more complete picture of American chemistry can be ascertained by including also the *American Chemical Journal* edited by Ira Remsen. The first volume also appeared in 1879. Remsen (17) was a member of the ACS from 1878 until 1881. His journal was founded as an outlet for the growing volume of research being produced by himself and co-workers at Johns Hopkins. Most of Remsen's previous work had been published in the *American Journal of Science,* edited by James Dwight Dana of Yale University. Dana had suggested that Remsen found his own journal as Remsen's work was becoming too specialized for the journal (18).

Ira Remsen
Editor, ACJ

Both journals initially had many similarities in that a considerable part of each issue was devoted to summaries of important work appearing in foreign journals. Reviews of the progress being made in various fields such as analytical chemistry were also part of many individual issues Volume I of JACS contained 32 pages of proceedings, 235 pages of original papers, and 324 pages of reviews, notes, and abstracts from foreign journals, as well as domestic and foreign patents. A major difference was that in JACS all the papers had been read at the monthly meetings of the society, whereas those in the ACJ were sent to Remsen in his capacity as editor.

Analysis of the First Volumes

In Table 1 are listed by discipline a comparison of the number of papers in the first issues of the British, German, and American journals under consideration.

In the first volume of the *Quarterly Transactions* all fields of chemistry are represented in almost equal numbers. Of the 11 organic papers all but two have a German connection. Hofmann and his students and assistants at the Royal College were responsible for six, three by Hofmann and one each from E.C. Nicholson, H. Medlock, and C. B. Mansfield. If we add to these contributions by persons with a connection to Giessen (S. Muspratt, J. H. Gladstone) then the number rises to 8 out of 11. The ninth paper was a collaboration of Kolbe (D. Phil., Göttingen) and Frankland, D. Phil., Marburg [Bunsen]). The importance of the German connection in organic chemistry and the Royal College of Chemistry (9) cannot be underestimated.

Table 1: Analysis of papers in Volume I by Subject Content–Number and Percent.

	Quarterly Journal (1849)		Berichte (1868)		JACS 1879)		ACJ (1879)	
Analytical	6	21%	5	6%	7	23%	9	21%
Inorganic	5	17%	19	22%	9	30%	5	12%
Organic	11	38%	54	62%	11	37%	26	61%
Physical	7	24%	9	10%	3	10%	3	6%

The first volume of the *Berichte der Deutschen Chemischen Gesellschaft zu Berlin,* appearing in 1868, consisted of a total of 87 items, these being divided in two types: 67 full papers and 20 communications. The first volume of the *Berichte* as well as subsequent volumes would contain only original papers. One cannot say with

any confidence whether this was a reflection of the shear volume of research coming from the universities and research institutes or of a certain degree of nationalism. All of the published material had been presented at the monthly meetings of the society by the author(s) or by a member of the society. The number of papers involving organic chemistry comes as no surprise, given the interest in the subject in Germany. The bulk of the contributions are from Hofmann and Baeyer and their circle of collaborators. The large number of inorganic papers is mainly due to the work of Carl Rammelsberg, the leading mineralogist in Germany at this time. Rammelsberg would contribute 20 papers in 1870, the peak of his scientific productivity.

Table 2: Educational Background for Authors in Journals

Highest Degree	Quarterly Journal		Berichte		JACS,
Ph. D	5	21%	20	53%	12
M.D.	4	17%	3	8%	2
MA, MSc, BA,BS	1	4%			11
No formal degree	14	48%	15	39%	

In both the JACS and the ACJ the subjects most frequently dealt with were analytical, inorganic, and organic chemistry. In JACS there are 90% in these three areas versus 94% in the ACJ. The preponderance of organic papers in the ACJ is obvious as this was Remsen's journal. Remsen, with the largest research group, was the most productive organic chemist in America. The interest in analytical chemistry in the US is to be expected given the wealth and diversity of raw materials and finished goods that America was producing during this era of industrial expansion.

In Table 2 are shown the educational backgrounds of the authors by their highest degree.

When the Chemical Society of London was formed, the emphasis on formal credentials to call oneself a chemist or even to teach the subject was not as important as it would become in succeeding decades. This was still the era when talented amateur gentlemen of science could make significant contributions. It is also evident that medicine in Britain was one of the major opportunities for studying chemistry and doing chemical research. Those seeking to enhance their knowledge of chemistry and obtain a formal qualification went to the various German universities. There they learned of the latest discoveries and techniques and perhaps earned the D. Phil. degree. Of those who had the degree in the first volume only three were British, the other two being German-born and educated (Hofmann and Kolbe).

By the time of the founding of the DCG a well developed system for the training of chemists was in place. Of the 95 Berlin members, 57 held the D. Phil. degree (60%), 23 were listed as chemical factory owners or directors (24%), 4 were apothecaries (4%), and 7 were listed as chemists without the D. Phil.(7.5%). As can be seen from the data 61% of the 38 authors of papers in the first volume held the D. Phil. or M.D. degree. Nowhere else in the western world was there such a system for educating chemists that would produce the next generation of academic and industrial chemists. German methods would have an especially important impact in the direction of British and American chemistry in future decades. Curiously, in Volume 1 of *Berichte* there are no American authors and only two contributions from the British chemists Warren De la Rue, Hugo Müller (London), and Peter Griess (Burton-on-Trent, England). Müller and Griess were expatriates and De la Rue had been awarded an honorary doctorate from Geissen by Liebig. The development of chemistry in America on the graduate level was influenced in large part by the assimilation of the German system (18, 19). Of the 42 authors of papers in Volume I of AJC and JACS we have been able to obtain the educational background of 25. Although incomplete it still represents a sample that can provide an overall feel for the American educational experience. Some American chemists after obtaining an American bachelors' degree then went on to study in various laboratories in Germany. Many stayed the required two years and obtained their D. Phil. degree. Others did not but, having acquired a superior knowledge of chemistry, were still offered academic positions on their return. Some chose to become manufacturers or consultants.

Table 3 shows an analysis of the contributors of three or more papers to the journals we have analyzed. The number three was picked to denote significant contributors and to provide a good cross section for analysis.

It is quite understandable that Hofmann is the only person who contributed three papers to the first issue of the *Quarterly Journal*, as he was the only chemist in Britain that had any ongoing, concerted research program in operation. By the time of the founding of the DCG and

Table 3: Authors of Three or More Papers in Volume I of Quarterly Journal (1849), Berichte (1868), JACS (1879), and ACJ (1879).

Name	No. of Papers	Institutional Affiliation	Education
A. W. Hofmann	13	U. of Berlin	
	3(QJ)*	Royal College of Chemistry	Dr. : Geissen
C. Rammelsberg	8	U. of Berlin	Dr. : Berlin
H. Wichelhaus	6	Docent, Berlin	Dr. : Bonn
C. Graebe & C. Liebermann	4	Gewerbeakademie Berlin	Dr. : Berlin(both)
C. Scheibler	4	Zentrallaboratorium der deutschen Zuckerindustrie	Dr. : Königsberg
R. Schmitt	3	Gewerbeschule,Cassel	Dr. : Marburg
A. Ladenburg	3	U. of Heidelberg	Dr. : Heidelberg
A. Oppenheim	3	Docent, Berlin	Dr. : Göttingen
A. Remele	3	Docent, Berlin	Dr. : Berlin
Leeds, A.R.!	12**	Stevens Institute	Dr. (hon): U. of New Jersey
Remsen, I !!	7	Johns Hopkins	Dr. :Göttingen
Michael, A !!	7	Private laboratory, Buffalo, New York.	Studied with Bunsen, Hofmann,Wurtz
Mallet,C !!	5	Univ. of Virginia	Dr. :Göttingen
Goesssmann, C. A.!	5	Mass. Agricultural College	Dr. :Göttingen
Endemann, H.!	3	Columbia School of Mines	Dr. :Marburg
Smith, E.F !!	3	Univ. of Pennsylvania	Dr. :Göttingen
Casmajar,P. !!	3	Havermeyer & Elder Sugar	Studied at Harvard, École Centrale,Paris
Gooch, F.A. !!	3	US Government	Ph.D. : Harvard

* Hofmann was the only author of three papers in volume I of Quarterly Journal.
** Many of the papers in JACS are very short, i.e. one page but are still numbered as individual entries in the index.
! denotes JACS, !! denotes ACJ

the ACS in 1867 and 1876, respectively, chemistry had advanced to the point where formal and highly structured training was required. The era of the talented amateur with little formal training making any significant contributions to the science had long passed. With few exceptions all the major authors reported in Table 3 had obtained a D. Phil. at a German university (20); or if they had not taken the degree, they had spent some time in study there. Increasingly, research as measured by papers published in journals became the province of the academic chemist whether at a university or a research institute supported by the public purse. This did not mean that industrial chemists were not doing important work, but their contributions were being overshadowed by the academics, especially in Germany. Of the 19 chemists in Table 3 only two were connected with non-academic organizations.

The Chemical Society of London produced the model for organizing and maintaining a successful chemical society. German universities provided the model for the education of a new generation of chemists. The cooperation between pure and applied chemistry was also a hallmark of the DCG, whereas in Britain this caused a major problem and led to the formation of two new societies catering to the applied aspects of chemistry. Americans learned from their German counterparts how to organize higher education and from the British how to structure a chemical society which could accommodate the interests of those involved in pure or applied chemistry as well as the establishment of a decentralized society. The publication of journals by the societies provided a way for chemists to become aware of the latest developments in a rapidly changing science, even if they were unable to attend meetings. Chemical societies and the journals they published serve as an indicator of the growth and development of the chemical sciences in the latter part of the 19th century.

ACKNOWLEDGMENT

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16. Brock has pointed out that the AAAS section on chemistry was so successful in providing "an adequate forum for debate, socializing and to review progress" that, in Brock's opinion, it was one of the reasons that Canadian chemists did not form their own society until 1942. W. H. Brock, *The Chemical Tree,* W. W. Norton, New York and London, 1992, 450.
17. For a biography of Remsen see: F. H. Getman, *The Life of Ira Remsen*, Journal of Chemical Education**,** Easton, PA, 1940.
18. Remsen, very critical of JACS, is quoted as pointing out the defects of the journal to his students at publications seminars. Having slapped a copy on the desk, he is quoted as saying, "And that purports to be the official organ of American chemistry." (Quoted in W.A. Noyes and J. F. Norris, "Ira Remsen," *Biogr. Mem. Natl. Acad. Sci. USA*, **1932**, *14*, 248.
19. For a classic study of the American students of Liebig and Wöhler see: H. S. van Klooster, "Liebig and his American Pupils," *J. Chem. Educ*., **1956,** *33*, 493-497; "Friedrich Wöhler and his American Pupils," *J. Chem. Educ*., **1944**, *21*, 158-170.
20. For studies of the German influence on American chemistry see: A. J. Ihde, "European Tradition in Nineteenth-Century American Chemistry," *J. Chem. Educ.,* **1976**, *53*, 741-744; O. Hannaway, "The German Model of Chemical Education in America: Ira Remsen at Johns Hopkins (1876-1913)," *Ambix*, **1976**, *23*,145-16; E. H. Beardsley, *The Rise of the American Chemical Profession,* University of Florida Press, Gainesville, FL, 1964, 14-22.
21. For a list of American and British chemists who obtained D. Phil. degrees at German universities between 1840-1914 see: P. R. Jones, *Bibliographie der Dissertationen amerikanischer und britischer Chemiker an deutschen Universitäten, 1840-1914,* Deutsches Museum, Munchen, 1983.