The Journals Crisis: Redirecting the Blame

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Publishers and librarians are the usual culprits blamed for the “journals crisis”, typically defined as an ever-tightening spiral of increasing serial prices and decreasing number of subscribers. An alternative viewpoint is expressed in this article—the author community bears the brunt of the blame for this situation. The glut of published articles, the surplus of journals, and the growing publication rate per academic chemist drive the crisis. Therefore, any global publication paradigm change must originate from within the author community.

The central avenue for primary communication of research among chemists is the printed journal. Largely ignored until recently by the practicing (and publishing) chemistry community, the “journals crisis”[1] that afflicts the library community has engendered responses from the librarians and the publishers. Unfortunately, the authors and readers of the chemical journals have been largely uninvolved in seeking solutions to the crisis. In this article, an examination of the role that authors have played in creating the “journals crisis” is explored and options for how authors can regain control of their literature are proposed.

THE “JOURNALS CRISIS”—WHAT IS WRONG?

The definition of the “journals crisis” is dependent upon the target audience, varying from publisher to librarian to author. The focus of this article is the role of the author, and, therefore, we define the crisis in terms of how the journal crisis impacts the author. Many of the attributes described will also be appropriate for the library and publishing communities as well, but some issues pertinent to these constituencies will not be addressed here.[2]

The research chemist as author has two needs: (1) a mechanism for facilitating widespread distribution of his/her work in a timely manner and (2) archival retrieval of the work into the future. Any barrier toward universal access of research on demand will be seen as a detriment. A crisis situation would then be defined as an inability of researchers to reach their peers.

The research journal began as a response to the inadequacies of personal communication between author and a fellow scientist.[3] Personal communication simply failed to offer wide initial access to the materials and woefully lacked any means for systematic archival retrieval. The journal initially arose as a means for collecting research reports into a bound and printed issue. The journal issues could then be distributed in an organized and timely manner to the research community, principally via the mail or similar service. The ability to reach the community-at-large was achieved by individual and library subscription to the journal. Archival retrieval was offered by library repositories, which saved and stored the issues for future reuse. Largely unchanged since its advent in the 18th-century, the printed journal remains the authoritative mechanism for reporting chemical results.

Through World War II, chemical journals were produced largely by the professional societies. As the number of active authors grew, and the discipline became more specialized, the societies would occasionally add new journals to meet the demands of their members. As an example, in 1950, the American Chemical Society published only five journals: the *Journal of the American Chemical Society* (launched in 1879), the *Journal of Physical Chemistry* (1896), *Chemical Reviews* (1924), *Analytical Chemistry* (1929), and the *Journal of Organic Chemistry* (1936).

Commercial publishing of chemistry journals is a largely post-war phenomenon and primarily of post-Sputnik occurrence.[4] Capitalizing on the tremendous expansion of universities and research in the early 1960s, commercial publishers began offering chemical journals to meet the growing demands of both author productivity and splintering of the discipline.

The growth in chemical publication has been explosive over the past century. This is best presented as a plot of the number of abstracts indexed by *Chemical Abstracts* per year as shown in Figure 1.[5] Chemists now produce over 700,000 documents per year, clearly enough to satisfy the production needs of the myriad commercial and societal publishers. There has been concomitant growth in the number of journals published as well, a topic discussed in more detail in a later section.

The first aspect of the “journal crisis” is now evident—an explosion of published materials too numerous for any chemist to keep track of. The quote by Ziman from 1970 is perhaps even more apropos today—“Not only is there too much scientific work being published; there is much too much of it.”[6] However, a glut of information alone would not in-and-of itself cause a crisis.

The second aspect is the spiraling increase in journal costs. According to statistics compiled by the Association of Research Libraries,[7,8] the annual inflation rate for serials for the period 1986 to 1998 was 8.8%, or, in other words, the

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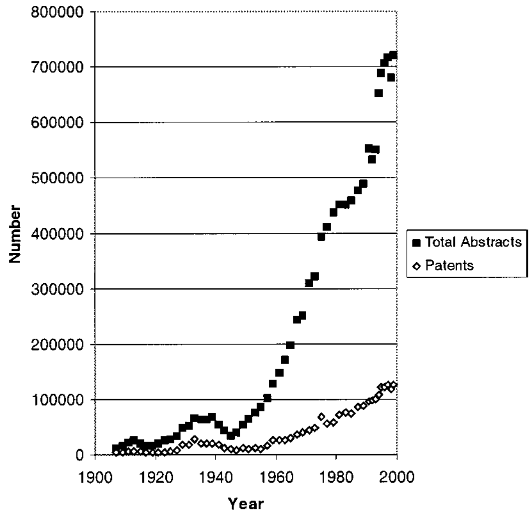

Figure 1. Annual number of abstracts and patents added by Chemical Abstracts Service.

average price of a journal increased by 175% over that period.

Rising prices are not a problem if library budgets keep pace, but this is far from the case. During this same period, library budgets have increased at a rate of only 5.2%, and the expenditures for journals have increased by an annual rate of 8.0%. This translates into a decrease of nearly 7% in the *number* of journals purchased by libraries over this time period. Of course, as subscriptions decrease and publishers receive less revenue, a publisher may respond with a price increase, leading to an ever-tightening circle of diminishing subscribers and higher prices.

The crisis becomes then truly a question of access to information. More and more chemistry is being published every year. More journals are being produced than ever before. Journal costs are increasing faster than the rate of library budget increases. The number of journal subscribers is decreasing. The net effect is that chemists have an ever-greater pool of information to explore but an ever-decreasing means of access to this information.

THE USUAL SUSPECTS

Librarians are up in arms deriding publishers, especially commercial publishers, for their pricing policies. Numerous studies of cost-effectiveness and pricing trends are available.[1,9,10] The SPARC[11] initiative of the ARL, a concerted effort by librarians to encourage lower-cost journals, is directed squarely at the economics of journal publishing.

Publishers counter that librarians have not effectively negotiated with their corporate and university administrations for larger budgets. They suggest that information and its distribution are expensive commodities and that libraries have not made this case.

Rather than engage in this finger-pointing battle, the thrust of this article is that the lion's share of the blame for the journal crisis rests on the shoulders of the research chemistry community itself—the behaviors of authors and readers have inevitably led to this untenable situation.

THE INSATIABLE DESIRE TO PUBLISH

Why do chemists write articles? The altruistic answer is that we publish scientific results to inform our community.

Table 1. Chemistry Departments and Their Rankings Used in Developing Faculty Publication Rates

institution	NRC ranking[12]
University of California-Berkeley	1
University of Illinois-Champaign	8
Yale University	12
Princeton University	20
University of Minnesota	21
Johns Hopkins University	27
Emory University	38
University of Georgia	49
Washington University	55
State University of New York-Buffalo	57
Notre Dame University	62
University of Cincinnati	72
Boston College	87
University of Nevada-Reno	98
University of Arkansas	103
Montana State University	107
Southern Illinois University	126

New science builds upon the old; publishing our work provides a mechanism for building upon the framework of what is known and provides a foothold for future work. In the free exchange of science, society can benefit as a whole with a growing knowledge base that can help solve problems and create new benefits.

Unfortunately, this idealized answer is not the whole truth. Publications also serve an individual's needs. Promotion and tenure within an academic structure requires proof of performance. Simple counting of publications provides an easy quantification. Successful grantsmanship requires evidence that solid work will be produced; how best to indicate future performance than by examining the publication track record?

From where is the growth in chemical publication originating? The publishing community can be roughly split into two groups: industrial and academic chemists. A sense of the article production of the industrial community can be garnered by examining the patent literature. Shown in Figure 1 is the number of patents produced compared with the total number of publications. If one examines just the post-war data, patent publication is growing at a rate of about 2500 more per year, while total chemical publication is also growing linearly but at a rate of about 14,000 more per year. Since patents largely reflect the industrial community, we can infer that the phenomenal growth rate must come from the academics.

To address the publication growth in academe, we have determined the number of publications per faculty member at the 17 institutions listed in Table 1. These Ph.D.-granting institutions span a large range of quality, as determined by recent National Research Council (NRC) rankings,[12] and include public and private institutions. Publication data were taken from the *Directory of Graduate Research*[13] for the years 1999, 1985, and 1967 and indicate the number of publications per faculty member for the previous 2 years. Data for assistant professors were neglected if the publications originated from work prior to the professorship appointment. Emeriti professors were excluded from the count.

The first point is that the size of the faculty at these institutions has changed very little over this time: 326 faculty members in 1967 and 399 in both 1985 and 1999. Publication growth is clearly *not* the result of simply *more* faculty.

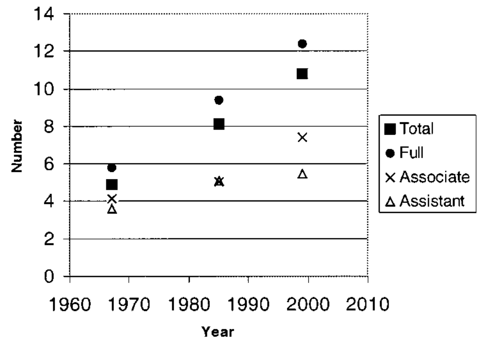

Figure 2. Average number of publications in previous 2 years per faculty member.

If there are not just simply more publishing chemists, then the increase in publication must arise from increased publication by each scientist. Figure 2 displays the average 2-year publication rate per faculty member as reported in 1967, 1985, and 1999. The most obvious trend is the linear growth in publication for all faculty, more than doubling from 4.90 in 1967 to 10.77 in 1999. Interestingly, the growth rate is small at the assistant professor level, from 3.59 in 1967 to 5.45 in 1999. The large growth is seen at the associate level and particularly for full professors. Significant increased demand for more publications to achieve promotion and tenure is not supported. Rather, it appears that the established chemistry faculty is driving the publication explosion. A pair of factors is likely at work here: a perceived need to publish more in order to attract and retain external funding and a larger pool of postdoctoral students who spend more time at this level. These postdoctoral students view a long publication list as bettering their opportunity for capturing permanent employment. Realize that support for the postdoctoral students usually comes from an external grant, which feeds back into the previous factor.

Can this growth rate be sustained? There appears to be no evidence for enlarging chemistry faculties, so the number of publishing academics should not dramatically increase soon. The number of Ph.D.s awarded in chemistry[14] has been relatively constant for many years now, indicating a relatively constant number of publishing chemists. The question reduces to whether faculty can continue to publish even more in the future. Certainly there is a fixed amount of time in a day, but whether we are saturated (or near saturation) is not readily identifiable.

Chemists, for whatever reason, simply author an enormous quantity of publications, as seen in Figure 1. This prodigious publication rate makes it impossible for any individual to remain current with all aspects of chemistry—one would have to read about 2000 articles every day of the year! Is it fair to ask whether this number of publications is necessary? Is it serving the needs of the chemistry community to fracture our knowledge production into so many pieces?

It is very critical to recognize that the source of these articles is the practicing research chemistry community. Publishers do not create journal content nor do they commission its production. The publication rate is determined solely by the community of authors. (In fact, peer review and page limitations imposed by a publisher can retard the rate!)

The chemical publication rate shown in Figure 1 is possible if the number of journals published and/or the number of

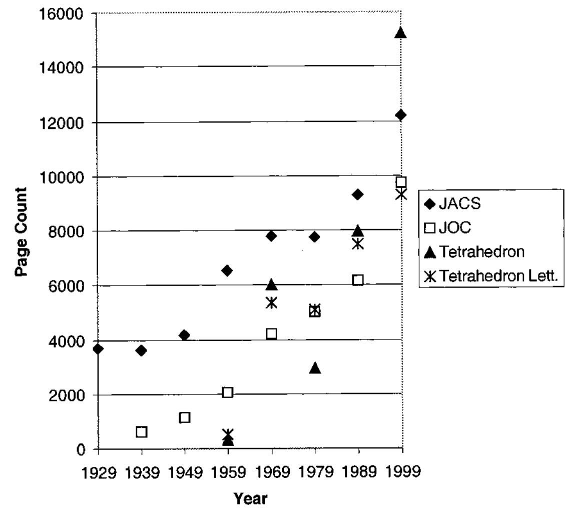

Figure 3. Journal page counts per year.

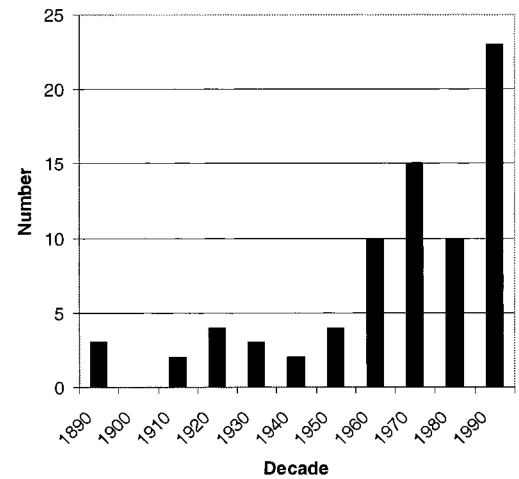

Figure 4. New organic chemistry journals launched per decade.

pages published by existing journals has also increased over the same time period. Instead of examining the whole of chemistry, we will evaluate the situation in the area of organic chemistry alone, realizing that the trends and conclusions will apply to all disciplines equally well.

Analysis of page counts per journal is complicated by changes in the size of the published page and the font and point size. Given this caveat, only a rough estimate of the increase in publication done by a journal can be gained by simply examining the page counts. Nevertheless, the trend is so clear that the point is made regardless. In Figure 3, we present the page count for four major chemistry journals in the field of organic chemistry: *Journal of the American Chemical Society*, *Journal of Organic Chemistry*, *Tetrahedron*, and *Tetrahedron Letters*. Inspection of this plot clearly indicates a steady (if not astonishing) increase in page counts, resultant from an increase in the number of article published.

We have identified 77 current chemistry journals that feature or publish a significant number of articles in the area of organic chemistry.[15] This list is available in the Supporting Information. A plot of the number of these journals launched in every decade of the past century is displayed in Figure 4. As anticipated, this plot shows increasing growth with time and an explosion of new journals this past decade. Again, one can wonder how any individual can keep track of so

Table 2. Niche Journals in Carbohydrate and Combinatorial Chemistry

title	publisher	launch
Field of Carbohydrate Chemistry		
Starch	Wiley	1949
Carbohydrate Research	Elsevier	1965
Carbohydrate Chemistry	Royal Society of Chemistry	1971
Journal of Carbohydrate Chemistry	Dekker	1974
Carbohydrate Polymers	Elsevier	1981
Carbohydrate Letters	Gordon Breach	1994
Carbohydrates in Europe	Wiley	1995
Field of Combinatorial Chemistry		
Molecular Diversity	Kluwer	1995
Biotechnology & Bioengineering with Combinatorial Chemistry	Wiley	1998
Combinatorial Chemistry & High Throughput Screening	Bentham	1998
Journal of Combinatorial Chemistry	American Chemical Society	1999
Combinatorial Chemistry	Elsevier	1999

many journals. Does this proliferation of journals enhance our scientific communication?

Particularly disturbing in this journal launch data is the duplication of coverage; two examples will suffice (Table 2). The subdiscipline of carbohydrate chemistry has a long tradition, dating back to the seminal work of Fischer. There are seven journals specializing in carbohydrate chemistry, two initiated within the past 6 years. Realize of course that other journals, such as the *Journal of Organic Chemistry* and *Tetrahedron*, publish articles covering carbohydrate chemistry. Is there really a need for *all* of these journals?

The past decade witnessed the birth of an important new concept and synthetic tool—combinatorial chemistry. Not willing to miss this bandwagon, over the past 5 years publishers have created five new journals (see Table 2) specifically focused on combinatorial chemistry. These new journals have not precluded authors from publishing their combinatorial chemistry research in other journals. Quite the contrary in fact: the older established journals continue to publish combinatorial chemistry along with these new ones. Pertinent questions here are whether the field of combinatorial chemistry needs all of these journals and whether the community benefits from having all of these publication options.

Commercial publishers produce goods that they believe can be sold and sold for a profit. New journals are, therefore, created with the intention of reaching some niche market. So what drives the publisher to believe a new journal can succeed? Certainly a number of factors must converge: a desire from some segment of the community to have a new journal, presumably authors who find it difficult or inconvenient to publish in the extant journals; senior scientists willing to serve as editors; and libraries and individuals prepared to subscribe.

Again, it must be plainly conveyed that it is the author and reader community (which is essentially one-and-the-same) that provides the backing, or lack thereof, to any new journal. If there are few available contributing authors, then a new journal will be devoid of content, and librarians will find little reason to subscribe to the new venture. There is nothing sacrosanct about a scientific journal; it does not *have* to exist.

TACIT JOURNAL SUPPORT

The obvious mechanism with which chemists support a journal is by subscribing or encouraging their library to subscribe. While this directly places revenue within the publisher's pockets, chemists actively participate in the financial success or failure of a journal by the standard process in which the vast majority of journals function. Examine the process in which a manuscript becomes a published article.

Step 1. The chemist conducts a research project. Financial support is provided by some government agency, the academic institution, or a corporation, decidedly not by the publishing house.

Step 2. The chemist writes the manuscript and submits it to a journal for consideration for publication.

Step 3. The editor, a member of the research community, locates appropriate referees and directs the manuscript to these individuals. Editors are generally paid for their efforts, though with relatively low stipends.

Step 4. The referees review the manuscript. This service is performed with no fee. The community has determined that peer-review is a benefit for all, and, therefore, it is the civic duty of all active researchers/authors to participate *pro bono*.

Step 5. Once the manuscript is accepted, the author typically will transfer all ownership rights to the publisher. The author is not compensated for this work or for the transference of rights. For some society journals, a page charge is requested.

Step 6. Most chemistry journals are professionally copyedited and typeset. The publisher provides this service. Consider that some journals require camera-ready copy and again the costs for preparing such a copy are born by the author alone.

Step 7. The publisher prints the issue and distributes to the subscribers.

Step 8. In order for a colleague to read the article, payment to the publisher must be made.

This system was established with the very first journals, which were created by scientific societies.[16,17] These early society journals were established solely to benefit the community (widespread peer-reviewed distribution of science), not to make a profit. With the advent of commercial science journals, one wonders whether the same operating procedures are appropriate. Since some society publishers generate a profit, this question can be directed toward them as well.

Insisting on recompense for refereeing services or for copyright transfer must lead to either *higher* journal prices (to compensate for the publisher's higher costs) or a decrease in the publisher's profit margins (not a circumstance that typically leads to stockholder faith). Since neither of these end-results is satisfactory, what then can be achieved?

A TIME TO LOOK IN THE MIRROR

Instead of blaming the publisher for high journal prices, librarians for canceling journals, or administrations for not increasing acquisition budgets, the time has come for the research community to examine their own actions. We have created the circumstances that have inevitably led to the "journals crisis".

We publish an extraordinary quantity. We actively encourage the development of new niche journals. We support these journals by submitting articles, refereeing, transferring ownership rights of our articles, and encouraging our libraries to purchase them. We do all these things without financial remuneration.

Can one blame a publisher for exploiting this situation?

Recent activities within the publishing community and within the chemical research community begin to address some of the concerns relating to the "journals crisis". Consortia purchasing and publisher bundling of journals are beginning to rein in prices. Competition brought on by such efforts as SPARC[11] show signs of encouraging more reasonable costs. E-print and preprint services offer alternative models for distribution of chemical information.[18−20] A recent proposal "Principles for Emerging Systems of Scholarly Publishing" dictates nine steps for improving scholarly publishing, including a greater emphasis on quality over quantity when evaluating faculty.[21] Analysis of these efforts is not the purpose of this article. Rather, we emphasis that the journal authoring and reading community, i.e., the chemical research community, must be proactive in determining the course of chemical publication (r)evolution.

The chemical research community holds the key components to this future, for it is we that produce and consume the product. Before we adopt any change or new publishing paradigm, we must evaluate what our needs truly are and what benefits we must accrue. We must accept the responsibility for our publishing situation and redirect it toward a more useful and sustainable future.

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Supporting Information Available: Table of the 77 journals that cover the discipline of organic chemistry. This material is available free of charge via the Internet at http://pubs.acs.org.

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