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Current and evolving models of peer-review

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Abstract:

New models of scientific publishing and new ways of practicing peer review have injected a recent dynamism into the scholarly communication system. In this article, we delineate the context of the traditional peer review model, reflect upon some of the first experiences with open peer review and forecast some of the challenges that new models for peer review will have to meet. Our findings suggest that the peer review function has the potential to be divorced from the journal system, so that the responsibility to judge the significance of a paper may no longer fall exclusively to formal reviewers, but may be assessed by the whole readership community.

Keywords: peer review, open peer review, pre-publication review, post-publication review, scholarly publishing, scholarly communication

1. Introduction

The emergence of new models of scientific publishing –such as repositories, the open access movement, megajournals, overlay journals, blogs, and wikis– along with the

appearance of new ways of conducting peer reviews, both pre- and post- publication –open peer review, open peer commentary, and so on– have lent a new vitality to the current scene in scholarly communications. The digital environment has been the major catalyst for these changes, favoring the development of scientific electronic publishing and the emergence of new business models (Cassella and Calvi 2010; Correia and Teixeira 2005; Björk 2011; Dall’Aglío 2006). Traditional publishers consequently have invested in innovation, adapting themselves to the Web and offering new products and services.

The arrival of alternatives to the conventional academic publishing system, embodied in the progressive adoption of Web 2.0 technologies and in the increasing importance of the OA movement, has enabled the reintroduction of dynamism to a market dominated by a small number of publishers whose structure and practices had remained relatively static for decades. The alleged lack of innovation regarding the scientific evaluation processes or the peer-review function might be one of the most debated aspects of the so-called traditional journal system (Kriegeskorte, Walther, and Deca 2012; Byrnes et al. 2013), in part because of its direct contradiction with the dynamism of the current technological world.

This article is mainly focused on innovations beyond the conventional peer-review model (encompassing both single- and double-blind reviewing). After describing the current context, this article examines the first experiences of publications that have developed an open peer review system. Subsequently, we analyze some of the pioneering proposals for change, describe their potential advantages and disadvantages and identify some of the main challenges that they will have to face in the near future. Further, we reflect on the implications of the success or failure of these initiatives for the scholarly communications system of the future.

2. Traditional scholarly journal publishing

For decades, journals have been the cornerstone of the scholarly communication system. They have been responsible for registering and making public the knowledge that previously has undergone assessment, for establishing the precedence of researchers as discoverers within academia and for giving credit and recognition to scientists (Delgado-López-Cózar and Ruiz-Pérez 2009). However, in the new digital world, the fact that such key-functions as registration, validation (peer review), dissemination and preservation continue to be controlled primarily by publishers instead of by authors or researchers has

provoked the development of new proposals (Priem and Hemminger 2012; Kriegeskorte 2012) that may function as alternatives to the established system.

The emergence of new disruptive elements such as the Internet and the Web (Cassella and Calvi 2010; Anderson and Moore 2013) are challenging the status quo of the established publishing system, drawing attention to features of it that are not working properly. Provoking unrest too are the so-called serials crisis (i.e., an unstoppable journals pricing spiral despite the theoretical reduction in the production costs derived from electronic publishing) and the perception of a loss of control by authors over their scientific production (Keane 2011; Tanner 2007), largely due to restrictive copyright policies of some publishers. The typical length of the publishing process –which is not too compatible with the rhythms in the development of knowledge in some scientific disciplines– along with perceived inefficiencies of the scientific review process (Björk and Solomon 2013; Mulligan and Hall 2013) can also be seen as contributing to discontent with the scholarly communication system.

The need to improve certain aspects of the structure of traditional scholarly publishing, as pointed out by some authors (Priem and Hemminger 2012) does not prescribe the elimination of basic functions of publishing, however. The innovative approaches aim rather to refactor the academic journal system in the same way that, in the field of Software Programming, refactoring makes it possible to modify the source code of a program without changing its ultimate performance. Thus can the scientific community identify and subsequently improve those parts of the system which are not working in a satisfactory manner without adversely affecting the end products (Priem and Hemminger 2012). Identified as particularly in need of being refactored are the evaluation-related functions. The evaluation of the research activity, which takes place in two different stages, has been diagnosed with several weaknesses:

- a) At the pre-publication stage—biases and subjectivity, lack of accountability, slowness or ineffectiveness in detecting fraud or plagiarism are just some of the deficiencies identified within traditional peer review practices.
- b) At the post-publication stage—while Impact Factor (IF) and other traditional metrics may be adequate indicators of journal quality (or at least of its perceived quality), these metrics are not as reliable for specific papers (“Beware the Impact Factor”

2013). Furthermore, the IF value should be considered a projection, since the IF is based on expected citations instead of observed citations (Aguillo 2011).

With regard to the post-publication phase the traditional methods of research evaluation are being contested by the emergence of new forms of assessment and measurement of scientific impact that are supported by a modest segment of the academic community. Initiatives such as the San Francisco Declaration on Research Assessment (DORA), which aims to improve the ways in which the quality of research outputs is assessed, going beyond the IF and focusing on the article/product level, are illustrative of this trend. In a similar way, the explosion of the so-called Altmetrics or Alternative Metrics – which allow the measuring of the scope and popularity of any kind of scholarly communication expressions on the social Web (including datasets, software, presentations, preprints, posters, blog entries, as well as articles)– is making possible the addition of a third level to the measurement of scientific research: journal (e.g. Impact Factor), author (e.g. H-index) and, now also the individual research products.

In parallel, academic journals –until recently, the single channel of scientific communication– have had to contend with emerging competition from online content platforms and repositories that are supporting the dissemination of all kinds of research products, including datasets quite prominently (Priem 2013). Examples of this are Zenodo, Dataverse, DataUp, figshare and ScienceOpen. Even long-established publishers have also started to implement their own projects in this respect (e.g., Nature’s Publishing Group now has its *Scientific Data*).

3. The traditional peer review system

The peer review process may be defined as a quality-control system of research outputs prior to publication (Kling and Callahan 2003). Therefore, it is without question an essential part of the scholarly communication system. However, as will be discussed later, there is not one single peer review model (see Figure 1). The possibilities in this regard are numerous and they vary among different journals and publishers, as well as in the different level of openness adopted in each case and in the time at which the assessment process takes place. Nevertheless, there are two predominant variants on the current scientific publishing model: single-blind peer review, wherein reviewers know the author’s identity but not the other way around (Ware 2008; Ware and Mabe 2009; Ware 2011); and the further

constrained double-blind peer review, in which reviewers and authors are equally ignorant of one another's identity, as in the journal *Ecology and Society*.

The main benefits of the conventional peer review method, whether single- or double-blind, are considered to be (Ware 2011):

- Its improvement of the quality of published papers.
- Its work as a filter not only of the best scientific literature but also of the journals themselves, since these are subjected to a rating based on the researchers' perception of their quality. A stratification is understood whereby first of all there is a clear differentiation between journals with and without a peer review process and, subsequently, a gradation among the journals within the first group. This further classification is mainly based on the perceived thoroughness of the peer review process, considered to be proportional to the prestige or excellence of a specific journal.
- Its function as a certification system of the validity of the published contents, giving a seal of approval or a quality assurance to the papers.

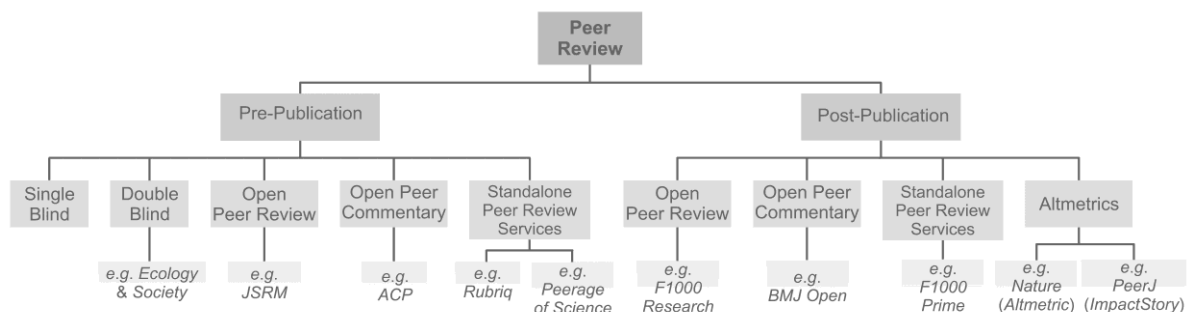


Figure 1. Current models of Peer Review

3.1. A troubled system

Although most researchers recognize the aforementioned virtues of the traditional peer review system and consider the reviewing function as an essential element of scientific communication, it is also true that some of its characteristics have been subject to criticism (Procter et al. 2010; Mulligan and Hall 2013), and a call for the introduction of changes.

From a general perspective, peer review exhibits problems that to some extent are inherent in the current scholarly publishing system—for example, its alleged conservative nature, which can hinder the use of innovative methodologies or the publication of research results contrary to dominant theories (Campanario 2002). Furthermore, the increasing pressure for publishing, along with the growing number of researchers, has led to fierce competition to be published in those considered the top journals. The chances of being rejected by the latter are greater of course, so that a process may begin in which a manuscript is subjected to successive evaluations until it is finally accepted by a specific, presumably lesser, journal (the so-called waterfall peer review). If we also take into account that it can be difficult at times to find qualified reviewers, the slowness of the process may be noticeable, resulting in significant delays in publishing times. This circumstance is in contradiction with the need for a rapid dissemination of science.

Moreover, reviewers have had to face criticism regarding their performance in assessing manuscripts. There have been unreliable reviews come to light, occasionally even contradictory assessments for the same manuscript (Campanario 2002; Casati, Giunchiglia, and Marchese 2007), whether due to the existence of opposing theories or trends or to preconceptions on the part of the reviewers. Another frequent criticism is the alleged elitism and lack of impartiality on the part of reviewers, manifesting in a tendency to favor specific institutions or researchers based on their position or prestige (Dall'Aglia 2006).

Finally, the traditional formulas of peer-review have been criticized also due to their ineffectiveness to prevent salami-publishing, the publication of multiple papers based on a single research work (Dall'Aglia 2006).

Other major problems of peer review that have been identified relate to the functions of anonymity, retractions and rewards.

An open secret: when anonymity is compromised

The most common forms of peer reviewing (single and double blind) share, as their main characteristic, the secrecy about the identity of the reviewers. However, this feature may not be always possible to achieve and sometimes it can even become a double-edge sword. The foundation of this method –to give reviewers, regardless of their academic status, the freedom to carry out their assessments without fear of future reprisals– can occasionally

result in unethical behavior (Mulligan and Hall 2013), such as hindering publication results or giving favorable assessments to particular institutions or signatory researchers.

The latter possibility is ostensibly prevented in the double-blind method, since the anonymity of both reviewers and authors leaves the personal issues out of the reviewing process. However, in practice the anonymity of both parties is not guaranteed, and identification has been proved to be relatively simple (Campanario 2002; Mulligan and Hall 2013). This is particularly true where reviewers can easily infer the identity of the authors—through the self-citations and references to affiliated institutions frequently contained in the papers. Moreover, articles are often framed within a research line developed by a specific group and/or researcher, so that the familiar pattern will probably be manifest in the introductory sections of new articles. Likewise, the suggestions or feedback received on the methodology or bibliographic references proposed by reviewers may give the authors a hint about the reviewers' identity, especially in those highly specialized fields in which researchers are very familiar with the work done by their colleagues. In these circumstances, the absence of full transparency combined with compromised anonymity can make it more difficult to deter or detect misconduct. To take all hazards into consideration, one must also acknowledge that both single- and double-blind methods are vulnerable to the possibility that, reviewers—as researchers themselves—may yield to the temptation to withhold or prevent the publication of works that are similar to those that they are developing or even, in extreme cases, to plagiarize unpublished ideas, acting from the shelter of anonymity. Those fields in which the research process is associated with significant economic interests and/or the participation of profit-making private entities may be particularly at risk in the review process.

The retractions problem

Another major problem of the traditional peer review process is its apparent inefficacy for detecting and preventing scientific misconduct, this time involving not the reviewers, but the authors. While a significant percentage of retractions are caused by methodological factors or unintentional errors, a larger share are due to misconduct, fraud, duplicate publication or plagiarism (Fang, Steen, and Casadevall 2012; Grieneisen and Zhang 2012). The frequency of discovered misconduct and retractions can be seen as an indicator of too frequent failure on the part of reviewers to ferret out research malpractice. Concerns over tainted research have led to the emergence of international organizations such as the Office of

Research Integrity (ORI) and the Committee on Publication Ethics (COPE) (Teixeira and Costa 2010).

Stories concerning needed retractions are emerging not only in specialized blogs such as Retraction Watch (e.g. one of the latest cases is the so-called Serbian Sokal), but also in general newspapers. The study carried out by *Science* correspondent J. Bohannon (Bohannon 2013), which was intended to discredit the open access model, has also served to demonstrate deficiencies of the traditional peer review process in current scientific publishing in general, regardless of the nature of the journals. The shortcomings of the current peer review process as reflected in retractions seem to equally affect both high and low-impact journals (Fang and Casadevall 2011; Fang, Steen, and Casadevall 2012; Brembs and Munafò 2013) and, both open and non-open access journals.

The incentives dilemma

A question that also deserves some attention concerns the paucity of reward for the essential work done by reviewers—work that of course directly contributes to the profitability of the publishing houses. Perhaps most academic reviewers conceive of peer review assessment as a natural part of their duties and responsibilities rather than as additional tasks that must be economically rewarded (Ware 2008; Ware 2011; Mulligan and Hall 2013). And it is possible that monetizing such activity would bring more problems than advantages, opening the door to positive assessments being exchanged for money. Some ambitious reviewers, upon the opportunity for profit, could accept manuscripts which fall outside their field of expertise or simply accept a higher number than they are actually able to handle. This could result in low-quality reviews or in more of the work being delegated to third parties who are not necessarily qualified. Some authors have suggested that the development and implementation of a future market of peer review services would help to avoid such dishonest practices (Priem and Hemminger 2012). However, it is not clear whether such a market would be able to self-regulate and avoid the problems we have described.

Based on the above, bestowal of academic credit seems to be the best solution to the incentives problem. There are multiple forms of value or academic reward that can be devised for reviewers, such as discounts on the article processing charges (APC) or free subscriptions to the journals for which they perform reviews. Receipt of officially recognized academic credit for meritorious review work –despite being considered by many the most

important type of compensation— is not widely employed or often presented as a record of significant achievement. In some English-speaking countries the information is sometimes included in the *curriculum vitae*, although its impact in eventual performance reviews and promotions is not always clear.

The accumulation of curricular credits for reviewing potentially can be achieved in at least two ways: through citations and through documentary/written evidence. Thus, those reviewers who are willing to sign their reviews and/or publish the reviewing reports could gain an academic credit in the form of traditional citations (Priem and Hemminger 2012). Nonetheless, it is important to take into account that the latter reward might depend on whether or not the publication of the reviewed manuscript finally takes place; while it is possible to publish a paper without its review report, it does not make sense to publish the review and not the object of reviewing process itself. Therefore, even when the quality of the assessment report is beyond question and the reviewer has invested valuable time on it, the eventual benefit to the reviewer will disappear if the paper is not finally published. And this could potentially lead to another problem: the possibility of reviewers consciously or unconsciously lowering their evaluation criteria in order to ensure the publication of the manuscripts.

The academic recognition of the reviewers' work does not necessarily have to be limited to the citations obtained by their published reviews. *Nature* has introduced two new ways through which the referees may obtain their own credit ("In Search of Credit" 2013). First, those reviewers who have performed at least three manuscript reviews within one year receive a free subscription to one of the journals published by NPG and an acknowledgement letter. Second, a new system allows referees to download a statement containing information on the number of reviews they have performed for the journal, giving them an official document that can be used to certify academic merit. We can hope that other publishers and societies will develop creative approaches to rewarding academics for their contributions as reviewers.

Finally, an ongoing initiative is also noteworthy: Epistemio (Florian 2012) explores the possibility of journals and/or funding agencies having access to a centralized system showing the work done by each review.

4. Alternatives to the traditional system: open peer review and open peer commentary

Although problems highlighted above have led to a realization that changes to the reviewing process are needed, agreement about the most effective way to carry them out has not yet been reached by the scholarly community (see Figure 1). Publishers have tested several alternatives in recent years that, despite their variability, are all linked by the common idea of making peer review a transparent and open process (Kriegeskorte, Walther, and Deca 2012; Kling and Callahan 2003). Meanwhile, the research community has not been indifferent to these problems, encouraging the proliferation of many alternative standalone review services and start-ups, such as Peerage of Science (PoS), Rubriq or, more recently, SciOR (Science Open Reviewed), PubPeer, Journal Lab, LIBRE, Axios Review and Publons.

Publishers have made an effort to face the flaws of the traditional reviewing system. Several journals have tried to implement new ways to assess manuscripts with the goals of greater transparency to the process and mitigation of misbehavior. Under some models, anonymity of both authors and reviewers has been discarded (e.g. *Journal of the Royal Society of Medicine*), and some journals have even started to provide public access to the reviewers' reports and to allow readers to submit comments (open peer commentary). These manifestations of so-called open peer review differ from one another, so that this new formula is rather complex and non-standardized (Ware 2011). Depending on the approach adopted by the journals, there are different kinds of open peer review, among them:

- Open reviews: specific paper (e.g. *Journal of Medical Internet Research – JMIR*).
- Open reviews: all papers (e.g. *BMJ Open*).
- Signed reviews: voluntary (e.g. *GigaScience*, *PeerJ*, *Atmospheric Chemistry & Physics – ACP*).
- Signed reviews: obligatory (e.g. *BMJ Open*).
- Signed reviews: pre-publication (e.g. *BMJ Open*).
- Signed reviews: post-publication (e.g. *BMJ Open*, *Frontiers*, *JMIR*).
- Readership access to reviewers' reports: required (e.g. *ACP*, *BMJ Open*, *BMC Medicine*, *GigaScience* or *The EMBO Journal*).
- Readership access to reviewers' reports: optional (e.g. *PeerJ*, *eLIFE*).
- Commenting systems for the readership to utilize: pre-publication (e.g. *ACP*).

- Commenting systems for the readership to utilize: post-publication (e.g. *PloS ONE*, *Frontiers*).

Some of the open access journals published by the European Geosciences Union (EGU) can be considered pioneers, having introduced a public peer review system accompanied by an interactive discussion. This is the case for *Atmospheric Chemistry & Physics* (ACP) and *Hydrology and Earth Systems Science* (HESS), which have had such systems since 2001 and 2004, respectively. The implemented model comprises two different stages: the manuscripts are first subjected to reading and open discussion under the form of Discussion Papers, in which authors receive feedback from reviewers and readers (see Figure 2). Subsequently, authors prepare a second version of the manuscript reflecting the comments and suggestions proposed during the previous stage of the process. Finally, the editor makes a decision about the definitive acceptance of the paper or the need to proceed with a further review period. The papers that are finally published on the web are linked with their corresponding draft manuscripts and also their review reports, which are permanently accessible and citable. Despite the initial skepticism, this revised peer review system has been successfully working for more than ten years without causing negative effects on the credibility of ACP (with regard to Impact Factor, ACP appears as the second journal within its academic field, with a 2012 value of 5.510) or on other journals published by the EGU (Maron and Smith 2008). The success of this initiative may be the reason why similar open and multi-stage peer review models –whose advantages have been described by Pöschl (2010, 2012)– have been implemented by other journals, such as *Economics*, with its own variant of this model launched in 2007.

Another sort of open peer review with an approach similar to that developed by ACP –but with some peculiarities– is represented by the journal *Frontiers*. In essence, the peer review process for *Frontiers* consists of two steps: an initial assessment implemented in the traditional way (i.e., with assigned reviewers who work independently), followed by a real-time interactive discussion forum in which reviewers, authors, and editors discuss the paper along with the evaluations of the previous phase. This review forum remains open until a decision is taken; and the reviewers' identities are disclosed once the paper is accepted. Lastly, when the paper is finally published, readers can participate with their comments and opinions, which are also subject to review.

The screenshot displays the journal's interface for an interactive discussion. The header includes the journal title 'Atmospheric Chemistry and Physics' and the EGU logo. The left sidebar contains navigation links such as 'Home', 'Online Library ACP', 'Papers in Open Discussion', and 'Journal Metrics'. The main content area features the article title, authors (T. Canty, N. R. Mascioli, M. Smarte, and R. J. Salawitch), and a list of interactive comments (AC, SC, RC) with their dates. A 'Review Status' box indicates the paper is under review. The right sidebar includes a search bar, a 'Discussion Paper' section with a PDF icon, and social media sharing options.

Figure 2. Screenshot of an Interactive Discussion in *Atmospheric Chemistry and Physics Discussions* (doi:10.5194/acpd-12-23829-2012)

Another variant has been adopted by the newly launched open access journal *eLIFE*. Its assessment system is based on the collaborative work of reviewers and publishers, who act cooperatively from the moment they are assigned to the review of a manuscript. The aim is to provide the process with a clearly constructive character. Unlike *Frontiers*, the reviewers do not act in isolation at any step of the process; the journal –run by scientists and researchers rather than professional publishers– has set up a Board of Reviewing Editors formed exclusively of scholars whose identities can be publicly accessed. Thus, *eLIFE* will have to ensure the independence and the impartiality of peer review processes that are led exclusively by active researchers instead of professional publishers and, again, the question arises about how these researchers are going to be rewarded for their time and work. Under this model, the final publication of the reviewers' reports depends on the authors' decision.

In addition to *eLIFE*, 2012 brought the launch of another journal that aims to renovate the traditional publishing model: *PeerJ*. One might describe the *PeerJ* approach as halfway between the traditional review process and the open peer review models. In this open access journal, which also has its own preprint server, PeerJ Preprints, the researchers are guaranteed the right to publish as many papers as they want –theoretically after a previous and rigorous

assessment— following the payment of an affiliation fee. In turn, the membership entails the commitment of acting as reviewers of other *PeerJ* community members' manuscripts, performing a review at least once a year. Over time it may prove interesting to observe how reliable the reviews may be, since there is an obvious need for researchers qualified in those fields represented by the papers at hand, whereas those responsible for undertaking the assessments are limited to fellow affiliates (Davis 2012). Given that the right to publish within *PeerJ* is linked to the fulfilment of just one assessment per year, it may happen that some members will prove less committed, leading to superficial reviews and comments or even to members paying the affiliation fee again rather fulfilling the review obligation.

The screenshot displays the F1000Research website interface. At the top, there are navigation tabs for FACULTY of 1000, F1000Prime, F1000Research, and F1000Posters. The main header features the F1000Research logo and a search bar. Below the header, the article title "Considerations for clinical read alignment and mutational profiling using next-generation sequencing [v2; ref status: indexed, http://f1000r.es/NMpsFc]" is prominently displayed, along with the author's name, Gavin R Oliver. The article is marked as "UPDATED" and has received 6152 views and 793 downloads. The abstract discusses the challenges of NGS technologies in clinical settings. On the right side, the "Open Peer Review" section shows "Invited Referee Responses" from three reviewers: Thomas Friedman, Vera Kalscheuer, and Mihaela Pertea. The article is marked as "UPDATED" and has received 6152 views and 793 downloads.

Figure 3. Screenshot of the *F1000 Research* Post-Publication Open Peer Review (doi: 10.12688/f1000research.1-2.v2)

It is also worth mentioning the innovative development brought to the publishing market by the “Faculty of 1000” (whose beta platform was presented in the summer of 2012): *F1000 Research* is an open access journal in the biomedical field that represents one of the few cases of post-publication open peer review (Hunter 2012) (see Figure 3). This initiative will be soon accompanied by another online publishing platform with similar characteristics,

The Winnower. Under both *F1000 Research* and *The Winnower*, the dissemination of papers takes place regardless of the reviewers' assessments, which may be seen as either a positive or a negative.

As discussed above, some journals combine a particular approach to open peer review with the feature of commenting systems (pre- or post-publication). The journal *ACP* could be considered to some extent a hybrid between open peer review and open peer commentary; although the disclosure of reviewers' identities is voluntary, their reports are available to all interested persons to read. People may also comment on the manuscripts prior to publication. Other journals such as *BMJ Open* and *BMC Medicine* have gone a step further by combining open peer commentary with the most pure open peer review—the assessments are disclosed and signed; the reviewers' reports are also subject to open discussion (see Figure 4); and readers may take part in the debate by adding their comments and opinions once the final papers are published.

The screenshot shows the BMC Medicine website interface. At the top, there is a search bar and a navigation menu with links: Home, Articles, Authors, Reviewers, About this journal, and My BMC Medicine. The article title is "Exercise therapy for bone and muscle health: an overview of systematic reviews" by Kåre Birger Hagen et al. The page highlights "Pre-publication history" and "Pre-publication versions of this article and reviewers' reports". A table lists the submission and review process, including original submission, reviewer reports, resubmissions, and the final published version. The right sidebar contains viewing options (Abstract, Full text, PDF), associated material (PubMed record, Article metrics, Readers' comments), related literature, and tools for downloading and sharing the article.

Pre-publication history

Exercise therapy for bone and muscle health: an overview of systematic reviews

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Reviewer's Report	Manuela Ferreira	31 Jul 2012
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Reviewer's Report	Jun Iwamoto	10 Aug 2012
Resubmission - Version 2	Manuscript	23 Sep 2012
Resubmission - Version 3	Manuscript	24 Sep 2012
Reviewer's Report	Jun Iwamoto	28 Sep 2012
Reviewer's Report	Manuela Ferreira	04 Oct 2012
Reviewer's Report	Krystia Dziedzic	11 Oct 2012
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Editorial acceptance		25 Oct 2012
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Figure 4. Screenshot of the *BMC Medicine* Pre-Publication History (doi:10.1186/1741-7015-10-167)

Finally, NCBI has recently launched PubMed Commons, a system intended as a forum for scientific discourse integrated within PubMed. This move may signal a significant expansion of open peer commentary systems among journals.

4.1. The PLoS ONE model

Several initiatives, including some of those mentioned in the former section, have focused their efforts not only on increasing the transparency levels of the peer review system, but also on introducing new forms of understanding and new practices. As will be seen in the following pages, the main innovation here concerns the establishment of a clear separation between the review and assessment functions, as has been accomplished by *PloS ONE*.

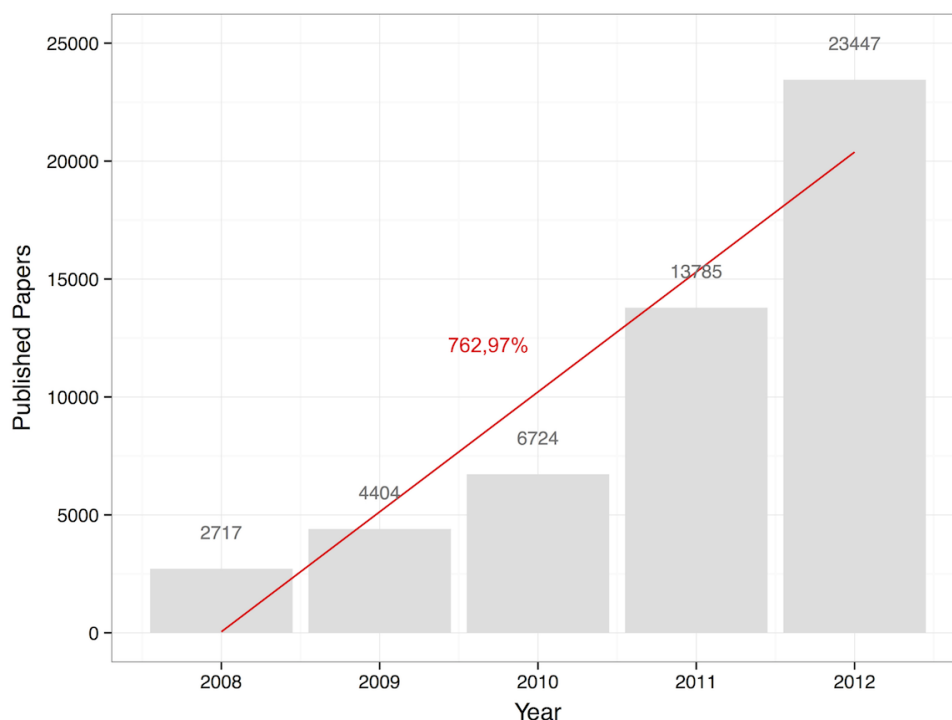


Figure 5. Number of papers published in *PLoS ONE* since its launch (According to SCI Thomson Reuters Web of Science)

The Public Library of Science, or PLoS –and, particularly, its megajournal *PLoS ONE*– has had great success in dissociating functions. In just one decade of activity, PLoS has launched seven journals that have managed to become ranked among the top positions within their respective knowledge areas. A search of the Journal Citation Reports (JCR) shows high Impact Factors (IF) for both *PLoS Biology* (2012=12.690) and *PloS Medicine* (2012=15.253), ranking respectively in the first and fifth positions within their academic

fields. But perhaps the most striking example is represented by *PLoS ONE* which, in the same year, 2009, achieved its inclusion in the Science Citation Index (SCI) and in the JCR (Roldán 2010) and, currently, ranks in the 7th position within its academic field according to the IF (2012=3.730). The appellation megajournal is quite appropriate considering the number of papers published each year (see Figure 5).

Leaving aside the possibility that high publication rates may influence the obtaining of a higher IF, what is interesting about the *PLoS ONE* model is the successful introduction of a change in the way in which both the editing and reviewing functions are performed. These functions are partially decoupled from the journal and carried out by new –and external– protagonists (Priem and Hemminger 2012). Therefore, *PLoS ONE* represents a significant departure from the current and traditional scientific publishing model wherein virtually all functions are performed within the publisher’s domain.

As Priem and Hemminger (2012) have pointed out, the manuscript preparation (typesetting process, assigning metadata, etc.) is done by the authors themselves rather than by the publishers of the journal. *PLoS ONE* has outsourced this function and it is the authors who decide how they are going to submit their manuscripts and what service they will use to do so. Yet the most significant change is introduced in the peer review process—and this may help explain the comparatively higher acceptance and publishing rates of *PLoS ONE*. In this model, the certification function is subdivided into two phases, the manuscript review and the post-publication assessment of articles. The review of the scientific rigor remains bound to the journal in the traditional sense, wherein specific reviewers are assigned for each paper and reviewers are limited to the role of deciding on the methodological soundness of the submitted papers. But the assessment of the potential impact of a specific paper takes place after its publication (Pattinson 2012) and is conducted by the scientific community not only through citations, but also through comments, downloads, views, tweets, likes, ratings, etc.—measured through the Article Level Metrics or ALMs. Thus, the so-called wisdom of crowds becomes the basis for considering the quality and results of each piece of research, with the assessment focused on the individual published work rather than the journal as a whole.

Such a distinction between review and assessment is not unique to *PLoS ONE*. Other journals that have adopted the same approach include *Frontiers*, *BMJ Open*, *Nature Scientific Reports*, *Springer Plus*, *The Scientific World Journal* and *PeerJ*, within the sciences; and *SAGE Open* and “Open Library of Humanities”, within the social sciences and humanities,

the first aspiring to become another megajournal like *PLoS ONE*, while the second –which is expected to see the light within a few months– is described by its promoters as a PLoS-style project for the humanities and social sciences.

All these journals share the same vision regarding the quality assurance system of scholarly contributions: the reviews must be focused on determining the integrity and scientific thoroughness of the papers regardless of their possible and future relevance and their eventual citations. The fact that all of them are open access journals seems logical, as you would expect OA titles to have faith in the effectiveness of open peer commentary systems, whether pre- or post-publication.

4.2. Challenges of open peer review and open peer commentary

There are still questions to be answered regarding the feasibility of open peer review. Reviewers may be reluctant to disclose their identity due to the fear of retaliation or resentments within the relatively small scientific community, especially if the assessments are negative (Mulligan and Hall 2013). The fact that some journals –such as *PeerJ*– have started to give reviewers positive points or the chance to publish their reviews as articles –such as in the case of Peerage of Science– in order to encourage them to write open reviews, may be taken as evidence of the complexity and uncertainty surrounding open peer review practices. And the fact that reviewers and authors know one another's identities can open the door to conceivable quid pro quo situations. Another important consideration is that the increased transparency provided by open peer review may not necessarily lead to an increase in the quality of the reviews, in terms of a more effective detection of flaws or in a reduction of the evaluation timeframes (Dall'Aglia 2006).

As for the commenting systems, both pre- and post-publication, it seems that the involvement of the research community in the production of blog entries or comments intended to improve the work of fellow researchers –and maybe also of competitors– has been rather modest; a case in point being *PloS ONE* (Cabezas-Clavijo and Torres-Salinas 2010; Public Library of Science 2011; Ware 2011). Pöschl (2012) has suggested that post-publication comment systems' participation is less attractive than it was envisioned to be because in this mode reviewers do not influence the final version of a manuscript with their comments. On the other hand, journals with pre-publication comment systems seem to be more effective in capturing public participation. While only one of twenty papers published

in *PLoS ONE* has received a comment, *ACP*, with its pre-publication approach, attracts comments at a rate of one in every five papers (Pöschl 2012).

And yet, we must acknowledge that the rate of comments on papers in *ACP* has trended downward too; in 2006, one in four papers received opinion statements from readers, not just from the assigned reviewers (“Systems: An open, two-stage peer-review journal 2006”), but by 2011, this average was reduced to one in five papers (Pöschl 2012). A thorough analysis of the published papers in this journal during 2012 shows that this average has been further reduced. In the aforementioned period a total of 741 papers were published, of which only 109 (14.7%) received some Short Comment (i.e., made not by reviewers, authors or publishers but by journal readers); this implies an average of only 0.2 Short Comments per paper (see Figure 6). However, the average (4.51) of all comments received per article, including not only Short Comments but also Referee Comments, Editor Comments and Author Comments (see Figure 7), remains stable and it is similar to that reflected in previous studies (Pöschl 2012). Interestingly, there is a great variability even among the different issues published in 2012 by *ACP*; some issues have not registered one single Short Comment (e.g. vol. 12, num. 10), while in other issues, papers have received a significant number of them (e.g. vol. 12, num. 15 has ten Short Comments).

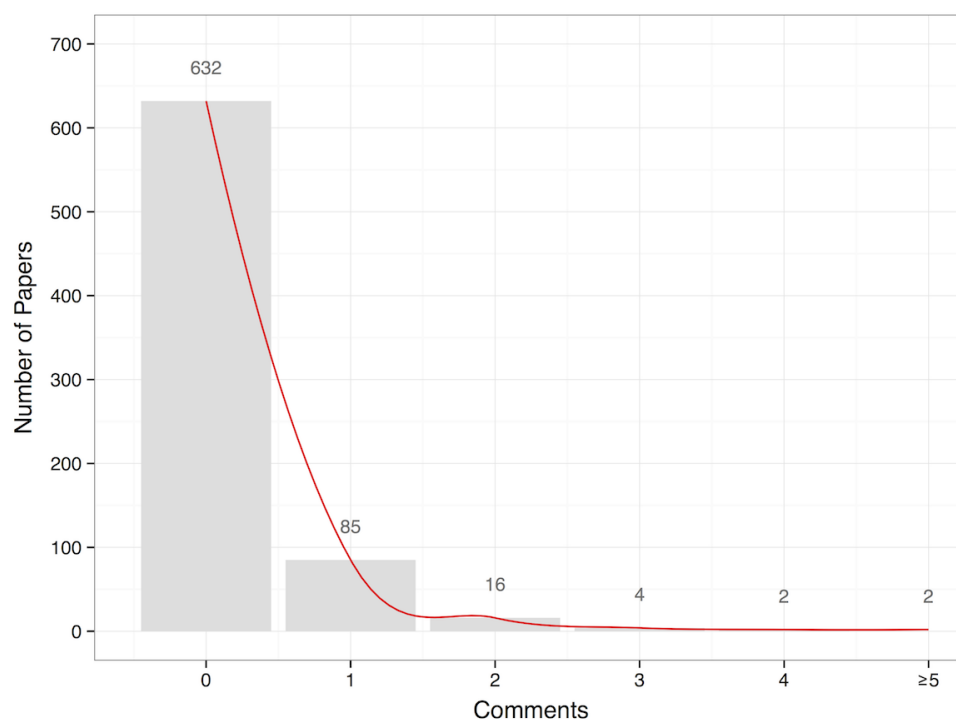


Figure 6. Number of papers according to the Short Comments received (ACP 2012, 12)

There easily could be other factors at play in limiting the participation of readers, independent of the moment (pre- or post-publication) at which that participation is allowed. Additional likely inhibitors would include the absence of rewards for commenters or the consideration that unpublished data or text used to support or dispute the work at hand are susceptible to being used by others in separately published works.

Although there is no shortage of journals employing commenting systems at present, their success, regardless of the implemented approach, has been quite modest to date in terms of users' involvement. In our opinion this situation could change if researchers could more often receive formal credit and recognition for these kinds of activities.

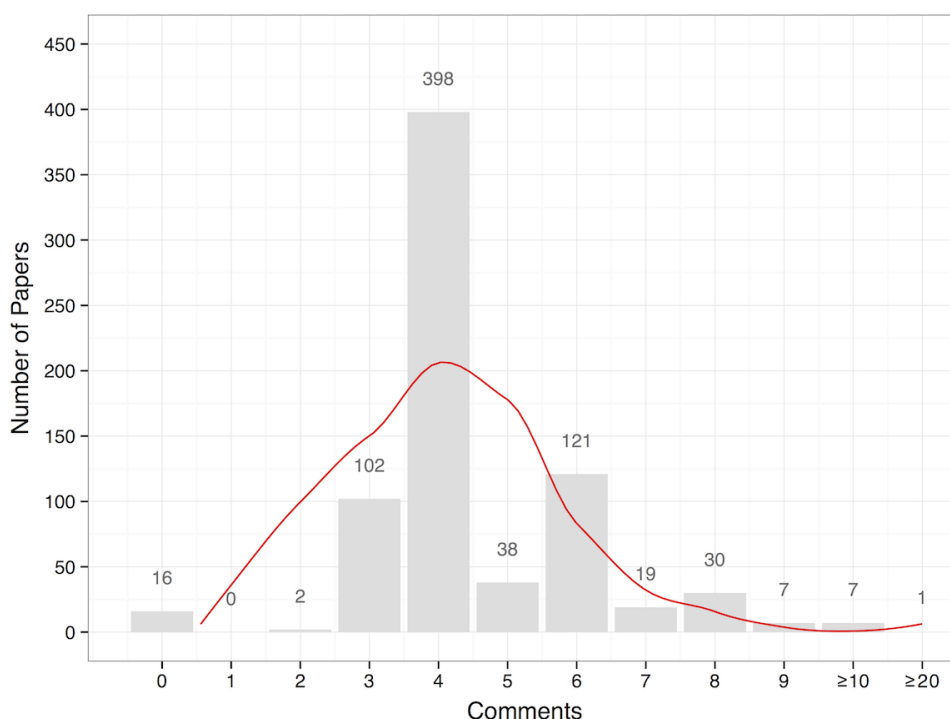


Figure 7. Number of papers according to the total amount of comments received (ACP 2012, 12)

Nonetheless we believe that open peer review and open peer commentary will ultimately result in more advantages than disadvantages. Besides improving the exchange of ideas and encouraging constructive debate, the fact that the report reviews are public may help to ensure the neutrality and objectivity of the process, acting as a deterrent against dubious ethical practices that may occur more frequently under blind peer review.

5. Toward a decoupled peer review

As we have previously highlighted, the certification function has been partially unbundled from publishers. Under evolving forms of review, the responsibility to judge the significance of a paper no longer lies within specific reviewers exclusively, but is undertaken by interested persons within the whole of the readership community. However, in this path toward the disaggregation of the reviewing function, there are also other initiatives that have been developed away from the journals. The advent of external reviewing services, which may be for-profit or not-for-profit organizations, is opening the way to privatizing the peer review function so that it can be executed outside the journals themselves

Rubriq is a for-profit and independent peer review system that offers manuscript review services to authors in the biological and medical fields. These reviews are made as a preliminary step to the submission of the articles for formal publication in an academic journal. The assessment stage (double blind) lasts approximately two weeks and it is performed –following a previously established methodology– by three reviewers who will be economically rewarded for their work. The review report (Rubriq report) provides the scores (Rubriq scorecard) merited by the manuscript in the judgment of the reviewers and advises the author which journals are most suitable for the work in order to increase their chances of being published.

At the same time, the journals that join Rubriq's network have access to both the manuscripts and the review reports (Rubriq reports). This means that journal publishers are able to select the best works even before the authors decide to submit them for publication. In this system, the pre-publication validation function is completely dissociated from journals, fulfilling the proposal made by Priem and Hemminger (2012) regarding the benefits of creating a decoupled metajournal or decentralized journal system. Ultimately, publishers will be responsible for deciding if the reviewed manuscripts are appropriate for publication in their journals or if they need to undergo further review.

Another example of an independent pre-publication peer review service is Peerage of Science (PoS), which has been in operation since November 2011 (Hettyey et al. 2012). PoS basically consists of one platform, accessible only to its members, where they can anonymously upload their works in order to be reviewed. The benefit of being reviewed entails, in turn, the obligation to review the work of third parties. Each member who carries

out a review will receive one credit; meanwhile, those authors who want to send a manuscript to the platform will have to pay a half-credit (de Vrieze 2012). To some extent, this model resembles the solution proposed by J. Fox and Owen L. Petchey (2010) for the creation of a central bank of credits called PubCred Bank.

Under the PoS solution, publishers could follow the review process of the manuscripts, enabling them to offer publication to those authors whose works have been assessed as viable contributions. Since the manuscripts are going to be reviewed just once in this system, the idea is trying to avoid a pilgrimage of authors from journal to journal until they find one that accepts the proffered manuscript, and at the same time reducing the workload of both reviewers and publishers.

Other mechanisms complementing peer review rather than replacing it are the online review services, such as F1000 –now F1000Prime–, which has been operating in the fields of biology and medicine since 2002 and 2006 respectively. The first purpose of F1000Prime is to identify and re-assess scientific contributions that have already been published and then, subsequently to rank and recommend them according to their relevance. A growing community of thousands of experts is responsible for undertaking such work (Hunter 2012). Another similar service but with apparently less impact at present is Peer Evaluation. The functioning of these kinds of services (including F1000Prime and Peer Evaluation) is premised on the trust that has been placed in the wisdom of crowds; we might in fact call these crowdsourcing review services.

In recent months new standalone peer review services have also come onto the scene, such as LIBRE, Axios Review, or Publons, which are offering alternative or additional assessments following those already provided by journals. The creation of these could be seen as a further step toward the decoupling of scientific journals from certain traditional journal functions; and –while still at a very early stage– may represent a turning point in the way peer review is understood and practiced.

5.1. External reviewing systems: uncertainties around their future

The emergence of standalone peer review systems suggests that there is room for improvement regarding traditional peer review procedures, although there exists some uncertainty about the eventual success of alternatives (de Vrieze 2012; Harold 2012a;

Hettyey et al. 2012). Questions raised by these services may be considered from a threefold set of perspectives, that of researchers, publishers, and reviewers.

First of all, the number of researchers making an active use of these services will need to be high, since the functioning of such systems depends on the creation of a scientific community whose members will have to act as both authors and reviewers. If there is not a large enough number of reviewers and, above all, if they do not have the necessary knowledge or expertise for assessing specialized works, the model will probably fail. This also applies to the case of the new publishing schemas such as *PeerJ*. In short, the viability of the service will depend on the existence of a critical mass of participants. Moreover, it should be noted that those researchers with less financial resources will be at risk of being expelled from the system, since they may not be able to face the payments required by external reviewing services (in some cases the review rates can reach as high as \$600).

With regard to publishers, they will have to place their trust in these external peer review systems because, in contrast to the traditional model, they will no longer decide the suitability of the reviewers. The quality and reliability of the reviewers' reports, whose authorship is unknown, must prove to be so reliable that they can be taken on faith as effective enough. Moreover, the number of scholarly journals engaged with these initiatives will also need to be high. If the researchers feel that their participation is not going to be sufficiently rewarded due to the reduced number of journals affiliated with the system, the success of the model will be compromised. In this sense, it seems that, for now, PoS is going in the right direction, since it has obtained the support of some of the journals published by BioMed Central (Harold 2012b) as well as, more recently, the cooperation of *PloS One* and *PloS Biology* through a new "Connect" feature for authors, which allows authors to submit papers directly to those journals.

Finally, reviewers must receive adequate incentives. This leads us again to the persistent problem of the reward system. In the case of Rubriq and PoS, reviewers are rewarded for their work. There is nevertheless a difference between these two; whereas with Rubriq the reviewers obtain an economic compensation –\$100– for each report performed, under PoS the reward is of an academic nature and is fulfilled in two different ways. PoS has devised a peer review of peer reviewers or a cross-reviews process in which the reviewers score one another. This results in the setup of a Peerage Essay Quality index; based on it, a Referee Factor is created in order to reward those who are more competent. At the same time,

reviewers have the opportunity to publish their review reports in the form of a Peerage Essay, either in *Proceedings of Peerage of Science* or in other journals. Thus, these review reports are potentially citable.

6. Conclusions

As we have seen, both the scholarly communications system in general, and the peer review model in particular, have been subject to widespread debate. In the digital world, problems of the traditional journals system have become more obvious and journal publishers have been challenged by the emergence of alternative ways of creating, assessing and sharing scientific knowledge, which, nonetheless, in turn have not been totally successful in improving some of the most criticized aspects of the conventional system.

Some authors (Smith 1999; Baez et al. 2010; Priem and Hemminger 2012; Nosek and Bar-Anan 2012) have drawn up innovative theoretical proposals on how to improve the scientific communication system. These approaches are mainly based on the same idea: the separation from the journals of certain functions of scholarly communication. Not all the ideas put forward in the aforementioned papers have had a practical implementation so far; in fact, while the success of arXiv and other preprint servers is undeniable, the existence of a unique space where researchers can publish their scientific contributions independently of the traditional journals –either a megajournal or a mega repository– still seems far from being realized.

The restructuring of the peer reviewing function, however, is not only viable but also likely to result in the disaggregation of this function from the journal system. The successful implementation of various types of open peer review and commenting systems carried out by different journals in the last few years, along with the flourishing of new companies devoted to provide external reviewing services, supports this interpretation.

Regarding the certification function, things are changing fast, and the current scholarly communication landscape is undergoing important transformations affecting the refereeing process. This article has been intended to examine the current situation of traditional and alternative models for peer review, focusing on some of their most controversial aspects and intractable problems and describing the innovations that are transforming the landscape.

The incentives to the referees and the retractions problem are two major questions that have been widely debated and not yet fully resolved. Regarding the first issue, giving academic credit (through citations or written statements) seems to be the best solution for rewarding the crucial work of the reviewers—especially if we consider the possibility of economic incentives leading to the emergence of a black market of positive reviews. As for the retractions, we have seen that both high and low-ranked journals are equally affected by this problem. The pressure for publishing papers and doing so in top-tier journals (those with highest Impact Factor ratings) has probably contributed to the rising number of needed retractions being discovered. In order to reverse this upward trend, not only should the reviewing process be improved, but also the publishing process itself. The reviewers must be properly motivated; and the prepublication history together with all the data and supporting information should be available to everyone, making the full process as transparent and reproducible as possible. Impact indicators of scientific results should include metrics beyond Impact Factor—such as Altmetrics. Impact Factor at the journal level alone is an inadequate indicator for the evaluation of scientific production.

In recent years, several journals have tried to improve peer review processes. Their efforts have been focused on introducing openness and transparency to a system often characterized by anything but those qualities. The new formulas that feature commenting systems or provision of access to the referees' reports, exemplified by journals such as *ACP*, *BMJ Open*, *F1000 Research* and *PLoS ONE*, may point the way to replacing the more conventional model of either single- or double-blind peer review. The example of *PLoS ONE* is particularly noteworthy; its reviewing model operates on the basis of a clear separation between the review and assessment functions. This is not a minor variant on the conventional approach since this means that the certification function has been partially disaggregated from the journal (Priem & Hemminger, 2012). Other journals have also followed this trail with what appears to be a partial solution to the fundamental slowness of the traditional reviewing model. However, the adopted models to date have several limitations, especially with regard to the active engagement of a healthy number of researchers providing comments and assessments. We have seen that the participation rates are relatively poor within both pre- and post-publication commentary systems. The case of *ACP* (with an average of only 0.20 comments per published paper during the 2012) illustrates this problem.

The new journals and/or publishing platforms that have been launched in recent months are adopting a different publishing schema, which is based on the idea first of all to

publish and then to evaluate. Evaluation and dissemination are thus no longer consecutive steps when the publishing of the research product takes place before its assessment. This is the case for *F1000 Research*, ScienceOpen or *The Winnower*; and it seems that PLOS has also explored this possibility (Van Noorden 2013).

The certification function –traditionally tied to journals– is now offered as a separate service within a new niche market. The arrival of standalone reviewing systems such as Rubriq, Peerage of Science or LIBRE seems to recognize the necessity for a body of researchers independent of affiliation with particular journals or publishers. We believe that the proliferation of these new services might lead to great changes in the scholarly publishing system, enabling a real possibility of a wider decoupling/outourcing of the certification function from publishers and their journals than has been seen heretofore (Baez et al. 2010; Nosek and Bar-Anan 2012; Priem and Hemminger 2012).

Taking into account the recent evolution of the academic publishing landscape, it is difficult to make an accurate forecast on the future course of the new initiatives and services arising around peer review in particular, or on their consequences for the scholarly communications system in general. In the light of the various experiences considered in this paper, we can conclude that there is neither a perfect peer review system nor single model that fits for all journals. Rather, it is reasonable to believe that there are and there will be different reviewing formulas depending on the academic fields, disciplines or research communities or on the inclinations of societies and publishers. The innovations and changes that are currently affecting the reviewing model are both positive and necessary in order to improve, rather than remove, the system. Moreover, we believe that continued focus on greater openness and transparency will be found to be necessary. In this regard, the introduction of commentary systems along with public access to the signed reviewers' reports may well become more the rule than the exception, over time.

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