

## **The core inefficiency of peer review and a potential solution**

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Time is one of the most important commodities in scientific research, and yet so much of it is spent on peripheral and sometimes unnecessary activities. One of the most time consuming aspects of science is making it public. Even once a paper is written, the process of finding a journal that is willing to publish it can take months or years.

### **The dual role of journals**

Much of the pain in publishing science stems from the dual purpose of scientific journals. First, journals exist to conduct pre-publication peer review. Peer review aims to identify and reject papers with fundamental flaws while offering suggestions on how to improve the remainder. Papers that are improved to meet the journal's standards are accepted for publication, made presentable through the typesetting process and disseminated to the community. The second purpose of journals is filtration, whereby each journal has its own scope (i.e. subject area) and quality threshold; the latter is the answer to the question 'what is the weakest or most boring paper we would accept for publication?'. The filtration function of journals enables scientists to identify the most relevant and most important papers that pertain to their research.

The unfortunate side effect of filtration is that most editorial decisions are based on how well a paper matches the journal's criteria, such that (at any given journal) few papers are rejected because of issues with the science itself. Another phenomenon exacerbates the problem of rejections for novelty or scope: there is relentless pressure on academics to publish their work in the most prestigious journal possible. This pressure stems from increased competition for faculty positions and funding, and it encourages speculative submissions to high profile journals on the chance that the paper will be accepted. If the paper gets rejected, the next logical step is submission to the second most prestigious journal, and so on down the cascade.

The net result is that journals receive 3-5 times more submissions than they are able to publish. For a typical mid range subscription journal, 30% of papers are rejected prior to review, and 30% are rejected after assessment by external reviewers. A significant proportion of papers (almost 25% even among tenured faculty; Cassey & Blackburn 2003, 2004) thus end up being submitted to two or more journals before being accepted for publication.

## **The costs of peer review**

The cost of reviewing and re-reviewing papers until they find somewhere they fit is high. First, every submission must be evaluated by an editor. The editor must either write a decision letter giving the paper an immediate rejection, or choose six to ten suitable reviewers. Either of these tasks requires a considerable span of undivided attention. If the paper does go out for review, it is evaluated by two, three or even four reviewers over several weeks, with each reviewer spending a median of five hours on their evaluation (Ware, 2008). Once the reviews are received, the editor writes their decision. All of these activities impose a time cost on the scientific community, typically on the most productive or community minded researchers.

A round of peer review also carries a financial cost. Every submission must be checked by the editorial office staff to ensure that it meets journal guidelines. The office normally runs the review process as well, which entails checking reviewer identities and emails, sending review requests, and reminding overdue reviewers. Many larger journals employ managing editors to oversee the process and ensure consistency in editorial decisions.

Editorial office staff are paid professionals, and in the course of a typical 6-10 week review process they spend about 8 hours on each paper (T. Vines, unpubl. data). Some papers come back in as resubmissions or as revisions, and these require additional staff time. These editorial office costs are at the heart of why science publishing seems so expensive, as they are incurred for every paper that gets submitted but only recouped for those articles that get accepted (either as Open Access fees or subscription fees). The costs scale with the inverse of the journal's acceptance rate. Very selective journals assess ten or more papers before accepting one for publication, and in the process they spend thousands of dollars on salaries and related expenses.

## **Independent peer review: the process**

Given the high costs in both researcher time (>16 hours) and money (~\$300) for just one round of peer review, we must look for ways in which we can fulfill the dual roles of journals while minimizing the number of rounds of review. One potential solution is independent peer review. In the Axios version of this process (see <http://axiosreview.org>), the paper undergoes a standard round of review, but the editor is part of an independent editorial board and not a journal.

The process is as follows. Once the paper is written and ready for peer review, authors submit their manuscript to Axios. The authors also provide a ranked list of four target journals where they think it could be published. The paper is assigned to an editor, and the editor can either decide that it's not ready for peer review (and

return it to the authors), or select suitable reviewers. The editor can also ask the authors to revise their target journal list.

The remaining papers are then sent out for review. The reviewers are asked to comment on a) the novelty of the paper relative to recent articles in the same area, b) its suitability for each of the four target journals, and c) the overall technical merits and weaknesses of the work. Once two or three reviews are returned, the paper is returned to the editor for their decision. Depending on the comments from the reviewers, the editor may (for example) decide that it's not suitable for either of the top two target journals, but that the paper seems like a good fit for target journals #3 and #4.

With the authors' permission, Axios then sends a referral to journal #3. A referral is essentially a very detailed presubmission enquiry. It contains the manuscript itself, reviews from two or three expert reviewers, and the identity of those reviewers. The journal can then decide whether or not it would like the paper to be submitted. If not, a referral is sent to target journal #4. If journal #3 is keen on the manuscript, the authors are asked to revise their paper in response to the independent round of review, put into journal #3 format, prepare a response to reviewers, and submit it to journal #3 by their regular submission route.

Of course, the Axios reviewers may have identified a number of substantial problems with the paper, to the extent that none of the target journals are likely to request submission. In this situation the authors are asked to revise their paper, prepare a response to reviewers, and send the new version back to Axios. The editor then checks over the paper and the response, and makes a decision on where the paper can be referred. The referral process then proceeds as described above.

For independent peer review to be successful, the journal's Editor in Chief must feel confident in the opinions provided by the reviewers and editor at the independent review organization. It is therefore critical that the editors at the review organization be respected researchers in their field, preferably with editorial experience at one or more of the target journals. Table 1 lists the Axios Review editorial board for the field of ecology, along with a subset of the journals that have agreed to look at referrals from Axios.

When the review process at the independent review organization is as rigorous as a regular journal round of review, the referral provides roughly the same information as a journal regularly uses when making editorial decisions. If the journal does want a referred paper, the paper is then something like a resubmission: the journal has seen comments from external reviewers and they are still keen to see a new version. The version submitted to the journal is thus very unlikely to be rejected on the grounds of novelty or scope, and instead the decision mostly rests on the quality of the authors' revisions. The rejection rates for resubmissions are correspondingly much lower (20-35%), even at higher profile journals.

The effectiveness of the Axios approach is borne out in the acceptance rate of their referred papers. Once submitted to a journal, fully 80% of manuscripts are accepted for publication. Moreover, because the review process at the independent board is so similar to the standard journal review process that journals are often willing to accept suitable papers without sending them back out for external review. Currently, about 50% of papers referred by Axios are accepted without further review. The process is also relatively quick, in that the review stage takes 4-7 weeks (much like a typical journal), and the referral stage an extra 2-10 days. Excluding the time the authors spend revising the paper, we average three months between submission to Axios and publication at the journal.

As mentioned above, administering a round of peer review involves salary costs for the editorial office staff, and Axios is no different in this regard. To cover these costs we charge authors \$250 USD for the use of our service; this amount is sufficient to cover expenses and leave enough spare to deal with unexpected events. The service is free to journals, although some Open Access titles (e.g. those from the BMC series) deduct our fee from their Article Processing Charge.

### **Independent peer review: the benefits**

The Axios approach to independent peer review clearly benefits individual authors, as they are able to aim their manuscript at both high profile journals and safer choices without the hassle of submitting to each one in succession. While all journal submissions run the risk of being rejected, some (generally senior) researchers are very proficient at targeting their papers to the right outlets. However, early career scientists are responsible for writing and submitting many papers, and the intense competition for funding and jobs means they need to 'try their luck' at higher profile journals, even over the objections of their more senior colleagues. It is these researchers that have the most to gain by using Axios.

Journals also benefit. Because authors are submitting their papers to journals that want them, journals are (by the same token) receiving papers they actually want. Unsuitable submissions are steered elsewhere, either by the Axios editor or at the referral stage. The net effect is that the journal's acceptance rate rises. Many rounds of review that would end in rejection are eliminated, particularly those rejections on grounds of fit. The reduction in the number of rounds of review before a paper is accepted also makes life much easier for the reviewer community.

Ultimately, independent peer review might become the 'normal' way that science is evaluated prior to publication. Papers would typically receive one or two rounds of peer review (one independent, potentially a second at the journal), and the current burden on the reviewer and editor communities dramatically reduced. Most importantly, the journals' dual roles of improvement and filtration are maintained, while the time currently spent on unnecessary rejections for scope and novelty can be redirected towards more productive activities.

## References

Cassey, P., and T.M. Blackburn. 2003. Publication rejection among ecologists. *Trends in Ecology and Evolution* **18**: 375–376.

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Table 1. The current Axios editorial board for the field of ecology and a partial list of journals that have agreed to look at Axios referrals.

Ecology Editorial Board	Ecology Target Journals
Stefano Allesina	American Journal of Botany
Julia Baum	American Naturalist
Michael Bonsall	Animal Biotelemetry
C. Titus Brown	Annals of Botany
Lauren Buckley	AoB PLANTS
Yvonne Buckley	Applications in Plant Sciences
Jarrett Byrnes	Avian Conservation and Ecology
Will Cornwell	Biological Invasions
Melania Cristescu	Biological Journal of the Linnean Society
Greg Crutsinger	BMC Biology
Brant Faircloth	BMC Ecology
Jeremy Fox	BMC Plant Biology
Kevin Gaston	Botany
Nicholas Gotelli	Canadian Journal of Fisheries and Aquatic Sciences
W. Stan Harpole	Canadian Journal of Microbiology
Carlos Herrera	Canadian Journal of Zoology
Randall Hughes	Climate Change Responses
Ari Jumpponen	Ecological Monographs
Bart Kempnaers	Ecology and Evolution
Jeremy Kerr	Ecology Letters
Katia Koelle	eLife
Nathan Kraft	Evolutionary Ecology
Brian Langerhans	Frontiers in Ecology and the Environment
Margie Mayfield	Frontiers in Zoology
Luc de Meester	International Journal of Plant Sciences
Ryan Norris	Journal of Biological Research – Thessaloniki
Camille Parmesan	Journal of Ecology
Rod Peakall	Journal of Fish Biology
Eric Seabloom	Molecular Ecology
Diane Srivastava	Molecular Ecology Resources
Jonathan Shurin	PeerJ
Matthew Symonds	PLoS Biology
Leho Tedersoo	PLoS ONE
Mark Urban	Systematic Botany
Jana Vamosi	Theoretical Biology and Medical Modelling
Koen Verhoeven	Theoretical Ecology
Hillary Young	Theoretical Population Biology