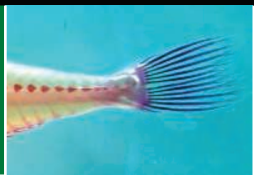

LETTERS

edited by Jennifer Sills

Declines in NIH R01 Research Grant Funding

IN ASSOCIATION WITH THE NATIONAL CAUCUS of Basic Biomedical Science Chairs, we have tracked funding of R01 grants (*1*–*3*). We found an R01 decline, which slows progress in fundamental research and deters bright young people from entering science.

In 2006, we reported (*3*) that between fiscal years (FY) 1999 and 2005, there was a sharp decline in the funding of unamended (i.e., as originally submitted) R01 applications. In the past 2 years, further declines have occurred for both new (Type-1) and renewal (Type-2) R01 applications (Table 1) (*4*, *5*).

New data for FY2007 indicate a substantial drop in the number of R01 applications submitted. However, during FY2006 and FY2007, further decreases occurred in total number of unamended applications funded and in dollar allocations. The 7% success rate of new applications implies that only 1 of 14 unamended applications was funded. For specific NIH Institutes, such as the National Cancer Institute, National Institute of Allergy and Infectious Diseases, and National Institute of Neurological Disorders and Stroke, success rates were even lower: 5%, 5%, and 3%, respectively. For renewal applications, the decline means discontinuation of 75% of ongoing programs.

Resubmission of amended applications—a slow, time-consuming process—increases likelihood of success (*6*) but protracts initiation of research. For ongoing projects (Type-2 applications), interruption of in-progress investigations often breaks up successful, experienced teams of investigators.

We also calculated annual allocations to the entire R01 program in relation to fluctuations in total NIH Research grant support (*7*). Since FY2000, R01 funding has suffered compared with overall funding, so that by FY2007 the deficiency reached almost $1.2 billion (Table 2). Rectification of this progressive decline in R01 funding would provide about 3200 additional research grants. Selective de-emphasis of R01 grants limits innovative discoveries for improving our nation's health.

Table 1. Fate of unamended, unsolicited "R01 Equivalent"* research grant applications (*4*)

FY	Number reviewed	Number awarded	Total $, millions awarded	Success rate %
Type-1 grants (new submissions)				
2000	10,284	2084	616.1	20.3
2001	9851	1864	599.6	18.9
2002	10,083	1831	617.5	18.2
2003	11,511	1733	587.6	15.1
2004	13,370	1595	551.8	11.9
2005	13,578	1236	443.9	9.1
2006	13,659	941	332.5	6.9
2007	12,021	864	321.1	7.2
Type-2 grants (renewal submissions)				
2000	3374	1787	589.9	53.0
2001	3218	1687	598.8	52.4
2002	3270	1614	582.7	49.4
2003	3922	1765	654.9	45.0
2004	3955	1606	613.2	40.2
2005	4128	1335	525.3	32.3
2006	3881	998	389.0	25.7
2007	3605	909	372.9	25.2

* "R01 equivalents" include a small number of R29 and R37, as well as P.A. grants.

Table 2. Progressive, steady decline in R01 grant funding during the past 8 years in relation to total NIH research grant support (*7*)

FY	Total NIH research grants	Actual R01* funds allocated	Calculated R01 fund, in proportion	Difference between calculated and actual funding (in millions)
2000	13,003	7141	7141	0
2001	14,908	8093	8187	–94
2002	16,830	8985	9243	–258
2003	18,461	9742	10,138	–396
2004	19,608	10,176	10,768	–592
2005	20,206	10,288	11,097	–809
2006	20,154	10,122	11,068	–946
2007	20,416	10,046	11,212	–1166

*These numbers are actual R01 grants and are exclusive of R29 and R37 grants.

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References and Notes

1. H. G. Mandel, E. S. Vesell, *Science* **294**, 54 (2001).
2. H. G. Mandel, E. S. Vesell, *J. Clin. Invest*. **114**, 872 (2004).
3. H. G. Mandel, E. S. Vesell, *Science* **313**, 1387 (2006).
4. Kindly supplied by the Division of Information Services, Office of Research Information Services, NIH.
5. The new data differ from those previously published because under unsolicited grants, NIH now combines R01 data with Program Announcements (P.A.'s). Success rates for P.A.'s did not differ appreciably from those for R01's, at least through FY1999 to 2005 when data for P.A. success rates were reported separately. For FY2004 and 2005, P.A.'s represented 20.4% of the combined pool, and for the 5 prior years the proportion was 15.6%.
6. For FY2007, first-time and second-time revisions have provided funding for an additional 1573 and 1272 grants, and $321.1 and $470.5 millions for new grants. For Type-2 amended applications, these numbers are 932 and 626, and $352.5 and $228.3 millions, respectively.
7. These figures include Type-1 and Type-2 grants, competing, noncompeting, and supplements; http://grants1.nih.gov/grants/award/research/Research_by_Activity_Code.xls.

A Call to Action for Coral Reefs

AT THE 11TH INTERNATIONAL CORAL REEF Symposium (ICRS) held in July in Fort Lauderdale, Florida, midway through the International Year of the Reef, more than 3500 experts from 75 countries assembled to face some hard truths: Coral reefs are teetering on the edge of survival, and it is our fault. High levels of carbon dioxide in the atmosphere can produce a lethal combination of warmer seawater and lower pH. Pervasive overfishing, pollution, coastal development, and physical damage further undermine reef health—and consequently the health of the people and ecosystems depending upon them (*1*).

Coral reefs feed, protect, and provide livelihoods for hundreds of millions of people around the world. They create homes for billions of fish and other animals, buffer coastlines from the ravages of storms, and provide rich economic opportunities through tourism and fishing. Their value to society has been estimated at more than $300 billion per year. Reefs are the dynamic centers of the most concentrated biodiversity on Earth.

It is not too late to save coral reefs. A consensus emerged at the 11th ICRS that society has both the knowledge and the tools to bring coral reefs back from the brink. We have a real—but rapidly narrowing—window of opportunity in which to take decisive action. We must immediately: (i) Cut CO_2 emissions by lowering our carbon footprint and ask our policy-makers to commit to low carbon economic growth. (ii) Eliminate open-access fisheries in coral reef ecosystems and instead establish and enforce regulations on user rights, total allowable catch, individual catch quotas, nondestructive gear, and other sustainable fisheries regulations. (iii) Protect coral reef herbivores, including parrotfish, by banning the harvesting of these species for sale and commercial consumption. (iv) Establish and strictly enforce networks of Marine Protected Areas that include No-Take Areas. (v) Effectively manage the waters in between Marine Protected Areas. (vi) Maintain connectivity between coral reefs and associated habitats; mangroves, sea grass beds, and lagoons contribute to the integrity of reef ecosystems and their continued production of ecosystem services. (vii) Report regularly and publicly on the health of local coral reefs. (viii) Recognize the links between what we do on land and how it affects the ocean. (ix) Bring local actors together—including members of industry, civil society, local government, and the scientific community—to develop a shared vision of healthy reefs and a road map for getting there.

Only by taking bold and urgent steps now can we hope to ensure that reefs will survive to enrich life on Earth, as they have for millions of years before us. By failing to act, we risk bequeathing an impoverished ocean to our children and future generations (*2*).

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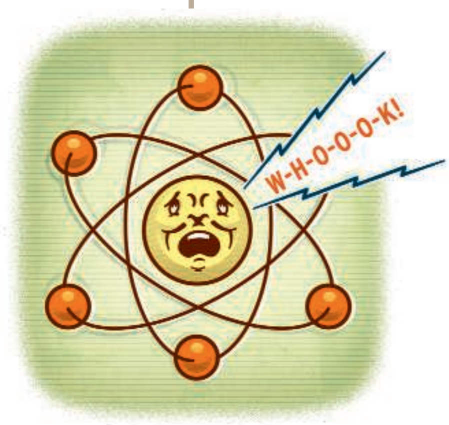
References and Notes

1. An overview of the 2632 papers presented can be found on www.nova.edu/ncri/11icrs/outcomes.html.
2. Please add your name to sign up for this Call to Action. Go to www.thepetitionsite.com/1/11th-international-coral-reef-symposium-call-to-action.
3. R.E.D. is the Chair of the 11th ICRS Local Organizing Committee (LOC); C.B., M.H., J.K., S.R.P., and O.H.-G. are Super Chairs of the 11th ICRS Mini-Symposia. R.v.W. is the Science Chair of the LOC. J.C.O. and B.D.C. are LOC organizers, R.B.A. is the President of the International Society for Reef Studies, and F.S. is Coordinator of the International Year of the Reef 2008.

LIFE IN SCIENCE

Sounds of Atoms

Early in setting up our nanoscience laboratory at Penn State, we were frustrated because we could not peer into the tunneling junctions of our scanning tunneling microscopes (STMs) to see what the atoms were doing. We were particularly vexed when singular events, such as an atom moving on the end of the STM probe tip, confounded our data and forced us to start over. Such an event was very difficult to identify; it would be just a blip in a recorded image or a flash on an oscilloscope, and it would not be recognizable at all in the frequency spectrum of noise monitored on our spectrum analyzer.



The solution to our problem was right there in the mirror every morning but had nothing to do with sight. Humans can hear a wide dynamic range and have a fantastic ability to recognize patterns in sounds. Borrowing a trick from electrophysiology, we sent the tunneling current of our microscopes into an audio amplifier and then turned our probe tip height into a tune by applying that signal to a voltage-controlled oscillator. One stereo channel corresponds to tunneling current and the other to STM tip height. This way, we could hear when imaging was proceeding well and when something was amiss. We applied this approach to every aspect of our microscopy and spectroscopy. The dreaded sound of an atom moving on the tip of a low-temperature STM has a characteristic rising "whoook" that is unmistakable (and sometimes heartbreaking). Every student, postdoc, and visitor in the group became familiar with the songs of his or her microscope—they learned which tune meant which problem and always rejoiced when they heard the best melody of all: the sound of a happily working microscope.

Such ideas were also developed independently at the IBM Zurich and IBM Almaden Laboratories, and elsewhere. If you would like to hear some of the sounds of our microscopes and of imaging molecules, please listen to the media files in the supporting online material (*1*).

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References and Notes

1. Some of the sounds of our microscopes, recorded by P. Han, A. Kurland, and P. S. Weiss of Penn State, are available as supporting material on *Science* Online (www.sciencemag.org/cgi/content/full/322/5899/190a/DC1).
2. Our original work was supported by the National Science Foundation, the Office of Naval Research, the Petroleum Research Fund administered by the American Chemical Society, and G. Marcotrigiano of Gary's Electronics.

EDITOR'S NOTE

This will be an occasional feature highlighting some of the day-to-day humorous realities that face our readers. Can you top this? Submit your best stories at www.submit2science.org.

CREDIT: PETER HOEY

Published by AAAS

Neutralizing the Impact Factor Culture

IN THE LETTER "PAINFUL PUBLISHING" BY M. Raff *et al.* (4 July, p. 36) and in the accompanying Editorial "Reviewing peer review" by B. Alberts *et al.* (4 July, p. 15), the authors succinctly outline the pressure being felt by both junior and senior scientists to publish in high-profile journals. Although not defined by the authors, high-profile journals are generally identified by and have become synonymous with Thomson high–impact factor scores. A common, but deeply flawed, practice has been to equate the importance and quality of a paper with the impact factor score of the journal in which it is published. In many cases, decisions on obtaining jobs, seeking tenure and receiving promotions and grants are being based on the impact factor of the journals in which an individual publishes. This creates enormous pressure to publish in high–impact factor journals. This situation has become so extreme that in some institutions the impact factor of each published paper in a scientist's bibliography is being requested and/or checked, junior scientists have become reluctant to initiate experiments that may not lead to publication in high–impact factor journals, and candidates for certain positions are being told that their chances are slim if they don't have papers in *Science*, *Nature*, or the like. As a result, many scientists are now more concerned about building high–impact factor bibliographies than their science.

The adverse effects of the impact factor culture must be reversed before more damage is done to the orderly process of scientific discovery. Although there may be no way of stopping computer-generated evaluation of journals and published papers, the scientific community certainly can control its use. To accomplish this, several concrete steps should be taken. First, each institution should make it clear, in a written statement, that it will not use the impact factor or the like to evaluate the contributions and accomplishments of its staff. Second, the heads of laboratories should prepare similar written statements and in addition discuss in depth with their fellows the importance of solid step-by-step science. Third, the editors of journals published by professional societies, joined by as many other journal editors as are willing, should indicate that they will not advertise, massage, or even state the impact factor score of their respective journals. By means such as these, it might be possible to put science back on the right track.

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Note

1. The views expressed here do not represent the position of the NIH.

Impact Factor Fever

IN A RECENT EDITORIAL ("REVIEWING PEER review," 4 July, p. 15) B. Alberts *et al.* addressed the most important problem affecting the scientific community today: the incredible pressure to publish, which is the drift of the "publish or perish" philosophy. Scientific quality is bound to suffer when scientists focus only on their publication records.

As an author, reviewer, and editor of a small international scholarly journal, I have noticed a dramatic increase in plagiarism, "salami-slicing" science, and other kinds of research misconduct over the past few years.

I fully agree that the peer-review process should be revised in order to reduce its length and make it less agonizing for authors, reviewers, editors, and readers (*1*). Some of the methods suggested in the Editorial, such as sending reviews on to other journals and enlarging the pool of referees, are certainly needed and will hopefully be successful. However, Alberts *et al.* failed to mention what is perhaps the most debilitating illness plaguing the scientific community, which I call the "impact factor fever." The exacerbated pressure to publish we all suffer from is induced by an exaggerated reverence for the impact factor.

Scientific achievement cannot be soundly evaluated by numbers alone. As Albert Einstein reputedly said, "Not everything that can be counted counts, and not everything that counts can be counted." How long must we wait until an antidote against the impact factor fever is developed?

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Reference

1. M. Raff, A. Johnson, P. Walter, *Science* **321**, 36 (2008).

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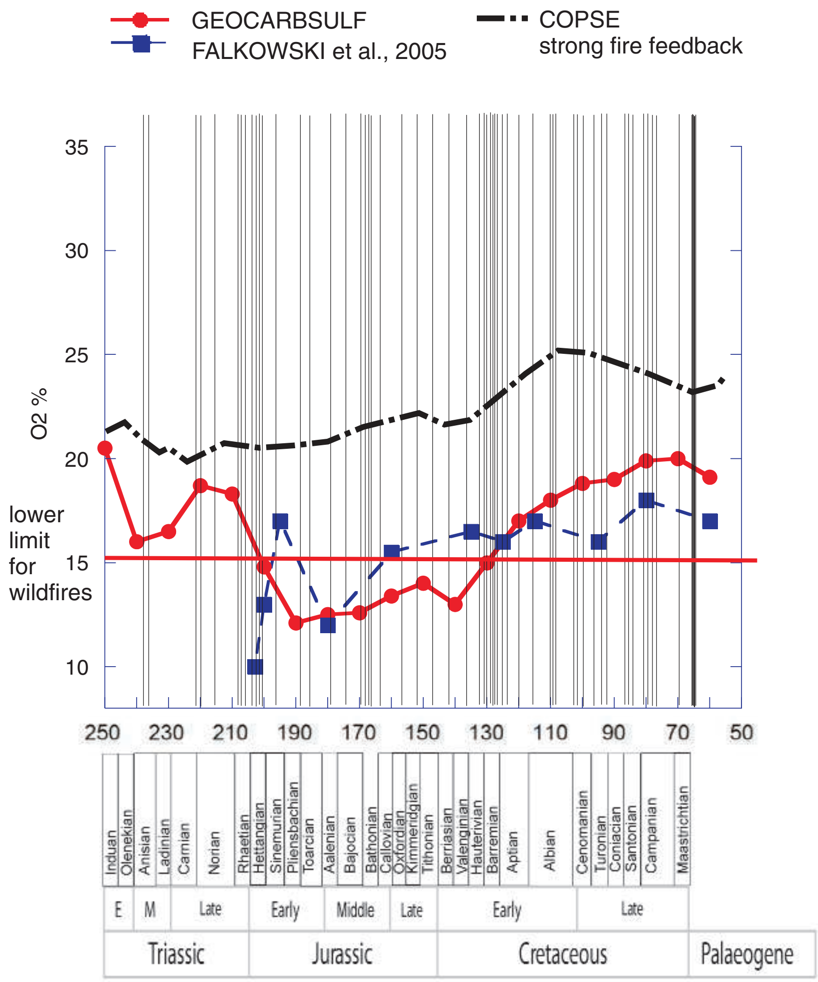
CORRECTIONS AND CLARIFICATIONS

ScienceScope: "Aussie science review" by E. Finkel (19 September, p. 1619). John Mattick is no longer director of the Institute for Molecular Bioscience. His correct title is Professor of Molecular Biology and ARC Federation Fellow at the Institute for Molecular Bioscience, University of Queensland.

Editors' Choice: "Adding less or substrating more?" (29 August, p. 1134). The penultimate word in the final sentence should have been "extinction," not "speciation." The final sentence should read, "Their results also show that an apparent excess of recently diverged lineages in lineage-through-time plots ... can be produced when declining net diversification is driven by increasing extinction rates." Also, the first author of the *Evolution* study was Rabosky, not Rabolsky.

Reports: "Limits for combustion in low O_2 redefine paleoatmospheric predictions for the Mesozoic" by C. M. Belcher and J. C. McElwain (29 August, p. 1197). In Fig. 2, the data point positioned at 250 Ma in the series labeled Falkowski *et al.*, 2005 is incorrect; it should have been placed at 205 Ma (see corrected figure below). There were several references to this in the text that need to be amended: The fourth sentence of the first paragraph on page 1197 should read "Few proxies have been developed for testing past atmospheric O_2 concentrations, particularly the low levels inferred for the Permo-Triassic (*4*) and the Jurassic (*2*, *3*)." The fourth sentence of the second paragraph on page 1199 should read "This analysis revealed that wildfires were prevalent throughout the Mesozoic and, coupled with data from our combustion experiments, did not support model-based predictions of low O_2 (<15%) for the Jurassic (*2*, *3*) (Fig 2)." The sixth sentence of the third paragraph on page 1199 should read "On the basis of our newly proposed low limit for combustion, both the Falkowski *et al.* (*3*) and GEOCARBSULF (*2*) models are currently incompatible with the record of fires in the Mesozoic, because they predict extensive periods of low (10 to 12%) atmospheric O_2 throughout the Jurassic (*2*, *3*)." This error does not affect the results or conclusions of this Report.



Technical Comments: Response to Comments on "A semi-empirical approach to projecting future sea-level rise" by S. Rahmstorf (28 September 2007, p. 1866; www.sciencemag.org/cgi/content/full/317/5846/1866d). It was stated that the semi-empirical formula for projecting sea-level rise can successfully predict the second half of the sea-level data when trained only on the first half of the data. This is correct, but it was illustrated by an incorrect figure (Fig. 1), in which the first half of the smoothed sea-level curve (1882 to 1941) was used to predict the sea level for 1942 to 2001. Because the smoothing procedure used a 15-year time window, the smoothed sea-level curve up to 1941 effectively contains sea-level information up to 1948. When this error is corrected and only annual sea-level measurements from 1882 to 1941 are used, the obtained fit gives a sea-level slope of 0.35 mm/year per °C, and the base temperature is –0.46°C. This is in fact closer to that obtained using the full data, and the sea-level prediction for 1942 to 2001 is within 1.4 cm of the (15-year smoothed) observed sea level (the Response stated that it is within 2 cm). No conclusions in the Response are changed by this correction.