tion" of a structure (Floyd E. Bloom, 13 Feb., p. 963). No structure is truly published until the atomic coordinates are provided to the scientific community. A group should be able to hold on to the coordinates as long as they like "before" publication, but they should not be allowed to have their cake and eat it, and eat it, and eat it some more, while everyone else is waiting. We can't even check it to see if it is real cake, let alone taste it.

Jason M. Johnson
Biophysics Program,
Harvard University,
Cambridge, MA 02138, USA
E-mail: johnson@arep.med.harvard.edu

■

ICRISAT's Accomplishments

The News & Comment article "Midlife crisis threatens center for semiarid tropics" by Pallava Bagla (2 Jan., p. 26) is critical of the impact of the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) on its stakeholders. As Bagla rightfully points out, ICRISAT's mandated crops are grown by resource-poor farmers in dry areas spread across 60 least-developed countries, and thus it would be unrealistic to expect dramatic improvements in those crops, unlike what happened with wheat and rice. Nevertheless, ICRISAT has made many positive contributions that are not clearly recognized. I mention a few such major achievements here.

■ More than 2 million germplasm accessions, breeding lines, and other material, including accessions originating from 130 countries, have been distributed worldwide.

■ Collaborative research by ICRISAT and national research programs has led to the release of 365 improved varieties of six crops in 70 countries. In addition, several hundred varieties are in the prerelease or advanced testing stages, and many are expected to be released during the next few years.

■ This research has been highly cost-effective. A study of a sample of 20 releases (out of 365) shows that these varieties have generated new income streams of $232 million—more than 10 times ICRISAT's annual budget.

■ ICRISAT scientists have developed a range of "intermediate products"—new laboratory protocols, standardized methods for disease screening, new insights into plant physiology, and techniques for virus detection—now being used widely by national scientists in different countries.

■ ICRISAT has helped train more than 3000 scientists and technicians from more than 90 countries. National research programs are stronger than ever before; the number of scientists with masters degrees or doctorates has tripled in several countries, and a number of national research programs are managed by scientists trained at ICRISAT.

ICRISAT has thus had a substantial impact on semiarid agriculture despite enormous challenges. It should receive continued and increased support and recognition for the sake of the billion or so, mostly poor, people it serves.

C. S. Prakash
Director,
Center for Plant Biotechnology Research,
Tuskegee University,
College of Agriculture,
Tuskegee, AL 36088, USA
E-mail: prakash@tusk.edu

■

Fractality in Nature

David Avnir *et al.* (*Science*'s Compass, 2 Jan., p. 39) pose the question, "Is the geometry of nature fractal?" By considering results from 96 reports that have claimed fractality in natural systems, they show that the declared fractality spans on the average only about 1.5 decades (orders of magnitude). Accordingly, they question the practice of

associating power laws over such a limited range of scales with fractal processes that by definition extend to an infinite range of scales.

This is a legitimate question, and I agree that natural systems are not described by simple scale-free models and that limited scaling may arise from random processes. There is, however, another possibility. Natural systems involve mechanisms and processes operating at different ranges of space-time scales. The climate system is a good example. The processes at those different scales may or may not interact with one other, but if they are fractal, their properties and scaling may be different and limited to the corresponding scales.

This kind of result can often provide useful insights about the physics and processes underlying the physical system in question. As such, the real issue is not whether or not we label the power law a fractal, but whether or not it is the appropriate fit to the data. In most studies, the power law is determined by the slope of a linear region in a log-log plot. In such plots, it is easy to visually identify narrow regions that appear linear. In effect, in most cases a power law is not proved, but is a priori assumed to exist. Very few studies (including those in the 96 reports) ask whether or not the data in the range of scales of the alleged power law are consistent with the corresponding family of true fractals or even if the power law is indeed the best fit to the data. This question is not always easy to answer, but in certain cases (self-affine processes, for example) statistical tests can be used to provide an answer (*1*).

A. A. Tsonis
Department of Geosciences, University of Wisconsin, Milwaukee, WI 53201, USA
E-mail: aatsonis@csd.uwm.edu

References

1. A. A. Tsonis and J. B. Elsner, *J. Stat. Phys.* **81**, 869 (1995).

Response: Tsonis raises two important issues—the possible origin of the limited range of empirical fractals and the practice of fitting data to a power law when there is no theoretical model that suggests the suitability of such analysis. Indeed, we also believe that the question of the origin and abundance of the limited-range fractals is the central issue. Theories that predict power-law scaling have been proposed and studied extensively for both equilibrium critical phenomena and nonequilibrium processes.

It seems to us, however, that the diversity of experiments and phenomena and the fact that most observations are as yet without a solid theoretical background call for a fresh look at the general phenomenon of empirical fractals with a limited range. Without claiming that we have an answer at hand, we do mention, as an example, an interesting finding we made, namely, that randomness, either in its elementary, uncorrelated forms or superimposed with internal correlations, generates apparent fractal structures below medium densities over one to two decades (*1*).

The question then, as correctly raised by Tsonis, is how can one distinguish between power laws that are the result of such nonmechanistic phenomena, and inherent power laws that fully justify the use of this analysis. We reiterate here the usefulness of the limited-range apparent fractals, even in the absence of an underlying theoretical justification (as we detailed in our *Science* piece). The detection and interpretation of inherent power laws requires scale-free theories and models. For some systems and processes, such theories and models exist, as mentioned above, while for others they are still needed. In any event, this task is far from being complete. We are currently developing guidelines and recommendations for the detection and analysis of fractal structures that are bound within cutoffs; these will be reported separately.

*Ofer Biham**
Ofer Malcai
Racah Institute of Physics, Hebrew University, Jerusalem 91904, Israel
**E-mail: biham@flounder.fiz.huji.ac.il*
Daniel A. Lidax
Department of Chemistry, University of California, Berkeley, CA 94720, USA
David Avnir
Institute of Chemistry and Lise-Meitner Minerva Center for Computational Quantum Chemistry, Hebrew University, Jerusalem 91904, Israel

References

1. D. Hamburger, O. Biham, D. Avnir, *Phys. Rev. E* **53**, 3342 (1996).

■

Responsive Chord

The recent editorial "Opening *Science*'s Compass" by Floyd Bloom (2 Jan., p. 10) struck a responsive chord. I believe that the new *Science*'s Compass could prove beneficial in establishing an expanded dialogue with nonscientists and policy-makers. As a professional environmental engineer, I often travel at the science/nonscience interface and continually marvel at the manner in which we humans can and cannot communicate—especially on scientific topics.

Being a longtime, omnivorous reader of *Science*, I have enjoyed exploring the diversity of unfamiliar subjects in attempts to expand my personal horizons and have composed a poem to this effect (*1*).

I don't know chicken hearts from lizard lungs.
When it comes to reading,
an unconscious defiance
Of the arcane term, or unfamiliar subject,
Precludes the understandable appliance.

But as expositions flow so breathlessly
upon the page,
From pens of you (and me), and Nobel giants,
My awareness of our wondrous universe
Increases geometrically–a Faustian alliance?

I attempt to learn the things I do not know,
But fervently, sincerely, place reliance
To lead me through the lexigraphical maze
Upon the Compasses of Science.

Stacy L. Daniels
3901 Orchard Drive, Midland, MI 48640-2679, USA

Notes

1. The first line was inspired by a letter of 2 January 1998 (p. 15).

■

Does Public Funding Corrupt?

To judge from the letters about funding for the National Endowment for the Arts (19 Dec., p. 2031) more people should read *The Economic Laws of Scientific Research* by Terence Kealey (*1*) and apply the argument to funding of the arts. If the case Kealey makes for private funding of science being more effective than public funding has any merit, then the case for private funding of the arts should be even stronger. The assertion that public funding merely corrupts the arts has much to recommend it.

Raymond R. White
Biology S-56, City College of San Francisco, San Francisco, CA 94112, USA

It was with great enthusiasm that I read Mark A. Emmert's editorial about the failure of scientists to stand up for federal funding for the arts (21 Nov., p. 1381). I completely agree with Emmert's suggestion that