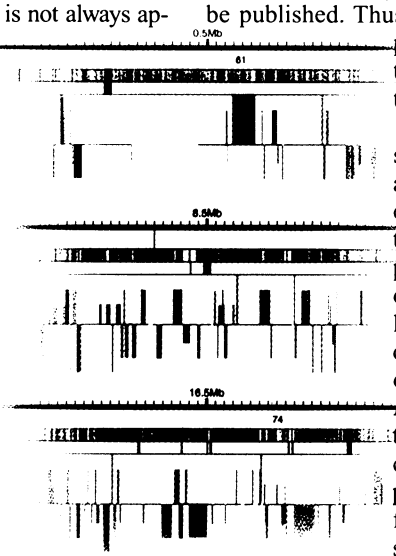
## Sequence Data: Posted vs. Published

**LARGE-SCALE DNA SEQUENCING PROJECTS** take a considerable amount of time to complete, including 2 to 3 years for the final or "finishing" stage. This fact is not always appreciated by those who are not directly involved in such efforts, as appears to be the case with Elaine Bell in her letter (1 Dec., p. 1696) about the Policy Forum by Lee Rowen *et al.*, "Publication rights in the era of open data release policies" (15 Sept., p. 1881). In her letter, Bell, as editor of *Immunology Today*, discusses what factors were considered in the decision to publish two articles that contained information from publicly available sequence data that had not been previously published. A major factor, according to her, was the *length of time* that the primary sequence had been available in the *public domain*" (emphases added). But the time referred to, about a year, is not adequate for such projects given the nature of the work involved.




**Finishing touches.** The final stage required to prepare a large sequence for publication can take several years. A small portion of the *Drosophila* genome is shown here.

Large-scale sequencing projects can be divided into three unequal stages: (1) random (shotgun) sequencing (a relatively fast process); (2) assembly of the shotgun data, done many times during the course of the project; and (3) finishing. During this last stage, physical gaps in the sequence are closed, ambiguities in the sequence are resolved, contaminating sequences are removed, and errors in the sequence are identified and corrected. Finishing is a slow process, often taking 2 to 3 years for large sequencing projects. Thus, the almost complete sequence will be available for an extended length of time while the sequence is finished and published.

Posted sequence (from stages 2 and 3), as well as sequence found in the GenBank database, is easily distinguished from published sequence. The posted sequence is often incomplete, might contain errors and contamination, and has not gone through peer review. In fact, the high-throughput genome sequence section of GenBank was established precisely to contain sequences not yet sufficiently complete and secure to be published. Thus, posted sequences are public, but they are not thereby automatically in the public domain.

Unpublished sequence should be treated as are all other unpublished scientific data. Therefore, a third party who wants to publish an analysis of other scientists' unpublished sequence should obtain the written consent of those other scientists. Absent that consent, that third party would be committing a "misappropriation of data" as defined by the National Institutes of Health (NIH) (http://ori.dhhs.gov/html/misconduct/regulation.asp). As such, misappropriation of data is one of the NIH definitions of plagiarism: "As a general working definition, [Office of Research Integrity] considers plagiarism to include both the theft or misappropriation of intellectual property and the substantial unattributed textual copying of another's work." Plagiarism is one definition of fraud in science.

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## Atmospheric Ethics

**THE IDEA OF EQUITY PRESENTED BY PAUL** Baer and coauthors in their Policy Forum "Equity and greenhouse gas responsibility" (29 Sept., p. 2287) with reference to apportioning the use of the atmospheric commons as a gaseous and aerosol waste dump might sound superficially attractive. They suggest that emissions be allocated "based on equal rights to the atmospheric commons for every individual." The idea of an equal per capita allocation of greenhouse gases, however, is flawed. It implicitly condones global overpopulation and rewards countries in proportion to their level of transgression of the human carrying capacity of their portion of the global biosphere. Per capita allocations are as ethically indefensible and ecologically counterproductive as allocations on the basis of past arrogations, which the authors properly condemn.

I suggest a more environmentally and socially equitable approach, which entails a two-step process (*1*). First to be determined is a safe (that is, sustainable) level of total global discharge of greenhouse gas emissions. Second to be determined is a country's allocation of that total on the basis of its air space: to wit, of its areal extent as a fraction of the total global land area under national jurisdiction. Most developed countries are probably discharging more than their fair share on this basis, whereas most of the developing countries are discharging less. The latter countries should be permitted to lease (not sell) a portion of their share to the former countries until such time that their industrial and transportation-sector developments require higher levels of discharge. In the meantime, the developed countries would have the time to institute various approaches to meet their fair allotment.

In short, the $5 \times 10^{18}$ kilograms of atmosphere circulating around the planet must finally become accepted by all as a common heritage of responsible humankind, perhaps through the vehicle of a comprehensive "Law of the Air" comparable with the 1982 Law of the Sea.

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References and Notes
1. A. H. Westing, *Environment* **31** (no. 3), 3 (1989); *Sci. World* **34** (no. 4), 5 (1990).

### Response

**A GLOBAL CAP ON GREENHOUSE GAS EMIS**sions is indeed needed, as Westing says. In our Policy Forum, we advocated an eventual target of under 3 gigatons of carbon per year, consistent with a sustainable oceanic and terrestrial sink and the stabilization of green-

house gas concentrations at less than double preindustrial levels. This target makes sense both in terms of an environmental "Hippocratic Oath," not to do harm, and in terms of achievable levels of emissions reduction on long-term technical, social, and demographic grounds. Kinzig and Kammen (*1*) present a detailed analysis of the possible transitions from the current path of runaway greenhouse gas emissions to these low-emission scenarios. Neither the rate of reductions needed nor the eventual targets are significantly affected by population.

Furthermore, we see no evidence that an equal per capita allocation would provide incentive to significantly alter national population growth. In fact, the climate-demographic interaction could help reduce population growth rates through increased investments (including those in health and education) that might be made possible by sales of emissions permits by developing nations under a per capita allocation scheme. In any case, we suggested in our Policy Forum possible solutions to any appearance of incentives for governments to adversely alter their population policies in response to per capita permit allocations. This can be achieved, for example, by choosing a fixed base-year population, by determining for each country a population baseline incorporating reasonable declines in population growth, or by allocating permits according to the population at some previous time point, for example, 20 years ago.

The concept of emissions rights proportional to land area suggested by Westing would result in enormously unequal allocations—an Australian would have many times the rights of a Fijian—without any justification other than the historical accident of national borders. The atmosphere is well mixed, and individuals are not physically restricted from accessing it as a sink; allocating its capacity proportional to land area makes no more sense than allocating rights to the deep ocean or Antarctica proportional to land area (both of which are governed for the good of all humanity under international law). In contrast, we argue that per capita allocations are justified by a common-sense principle of equality: that no one's basic rights should be contingent on their place of birth.

At a larger level, the collapse of the negotiations at the sixth Conference of the Parties to the U.N. Framework Convention on Climate Change in The Hague last November highlights a lack of understanding of the scope and importance of the climate issue and of the opportunities that exist to take positive first steps. Political leadership has proved, so far, to be lacking. In this vacuum, we believe that a consensual ethical principle—such as our proposal of environmental equity—is necessary to revitalize efforts to build an agreement.

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References and Notes

1. A. P. Kinzig and D. M. Kammen, *Global Environ. Change* **8** (no. 3), 183 (1998).

## Letters to the Editor

Letters (~300 words) discuss material published in *Science* in the previous 6 months or issues of general interest. They can be submitted by e-mail (science_letters@aaas.org), the Web (www.letter2science.org), or regular mail (1200 New York Ave., NW, Washington, DC 20005, USA). Letters are not acknowledged upon receipt, nor are authors generally consulted before publication. Whether published in full or in part, letters are subject to editing for clarity and space.

## Safety of Low-Cyanide Cultivars

WE ARE GRATEFUL THAT AFRICA'S NEEDS ARE on the agenda (Editorial, "Helping Africa feed itself," G. Conway and S. Sechler, 8 Sept., p. 1685). Yet, regarding V. S. Palmer and coauthors' plea in their letter (29 Sept., p. 2281) suggesting an international effort to rid cassava of cyanide as a dangerous toxin, I fear they are mistaken. From my experience (I chaired a session of 60 African scientists at the International Institute of Tropical Agriculture on the topic, and I teach about 100 new students each year and interact with many peasant farmers on their plots), many Africans say that the low-cyanide cultivars are safe with the normal cooking and food preparation methods used traditionally and that, if cyanide content were further reduced or removed, then they would lose their crop to baboons, porcupines, and a host of insects. I have run breeding field trials where the baboons have sampled the goods and left only the low-cyanide lines.

**Cassavas: It's in how you cook them.**

Cassava has great potential, especially if viruses are periodically eliminated by means of tissue culture cycles, which triples crop yields. The greatest need at the moment is for virus-resistant and mealybug-resistant cassava, which could be developed by genetic modification of locally popular lines.

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## Einstein's Motivation

"EINSTEIN'S INTELLECTUAL FEAT WAS ESPE-cially astonishing because, unlike the pioneers of quantum theory, he wasn't motivated by any experimental enigma." After I read this comment by Martin J. Rees in his Pathways of Discovery essay "Piecing together the biggest puzzle of all" (8 Dec., p. 1919), I searched and found that, contrary to what Rees says, Einstein was indeed motivated. Einstein wrote that he was "busy working on relativity theory in connection with the law of gravitation, with which I hope to account for the still unexplained secular changes in the perihelion motion of the planet Mercury—so far it doesn't seem to work" (*1*, p. 3).

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References and Notes

1. Letter to Conrad Habicht, December 1907, cited in L. P. Hughston and K. P. Tod, *An Introduction to General Relativity* (Cambridge Univ. Press, Cambridge; New York, 1990).

## Museum Collections and Conservation Efforts

THE VIEWS ABOUT BIODIVERSITY DATABASES discussed in the Bioinformatics for Biodiversity special issue (29 Sept., pp. 2305–2314) and subsequently in the 15 December Letters section emphasize that the range of such catalogs must be broad to be of maximum utility for taxonomists as well as conservationists. However, some of the discussions seem to imply that museum scientists are the custodians of an attic filled with historical biodiversity data that are not adequate for addressing contemporary conservation issues.

At the National Museum of Natural History, we add about a half-million new specimens of plants and animals each year from areas that have been little explored and from habitats of prime conservation concern. If this number is multiplied by the number of museums and botanical gardens worldwide,

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