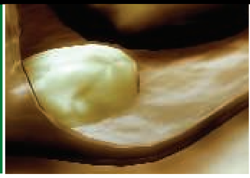

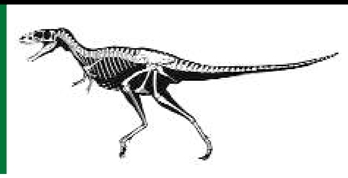

LETTERS

edited by Jennifer Sills

Turning Ivory Towers into a Golden Economy

IN EARLY MAY, STEVEN CHU—NOBEL PRIZE WINNER AND THE SECRETARY OF THE U.S. Department of Energy—announced that the federal government would underwrite the formation of eight energy research hubs. Somewhat modeled on Bell Labs, the energy hubs would help scientists take basic research discoveries and translate them into commercially viable technologies. This is a good first step toward better capturing the vast commercial potential residing in America's research laboratories and inside the minds of our talented graduate student researchers and scientists. Unfortunately, scientists and graduate students lack entrepreneurial skills, and few universities have aggressive plans to go beyond research to the translation of research into practice. Something is missing from teaching curricula, research plans, and federal funding policies.

The scientist entrepreneur's toolbox.

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We propose that translational research education be offered to every one of the 30,000 Ph.D.s graduating each year in science and engineering fields. Each student would have the opportunity to perform an impact or market analysis of his or her field; take mini-courses tailored to Ph.D.s in subjects such as business skills, finance and accounting, science policy, and entrepreneurship; and receive mentoring from successful entrepreneurs and from faculty from outside the sciences on how his or her work is informed by and affects society at large. If one in every five to ten Ph.D. students were to take on this extra dimension to their training, and if startup resources were provided for the top 20%, the total cost would be on the order of 1% of the federal basic research budget.

With little upfront investment, we could turn universities from basic science discovery institutes into powerful science and technology innovation engines. In as little as 2 years, such a program could have a strong positive impact on the economy.

Of course, not all scientists should become entrepreneurs. But more than ever before, students in the sciences are ready to follow the passionate path of entrepreneurship. Recent surveys from the National Academy of Engineering (*1*) have found that, more than at any time in recent memory, young engineering students want to use their education to improve the world. This is the classic definition of an entrepreneur.

Federal investment is needed because unlike undergraduate and master's education, doctoral education is funded almost entirely through faculty research projects. There is no agency with a mandate to accept proposals for translational research and education except on a pilot level—but we need our government to take ownership of this problem and the exciting possibilities a solution holds for our country.

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Letters to the Editor

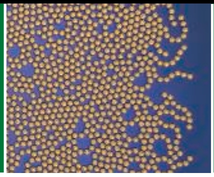
Letters (~300 words) discuss material published in *Science* in the previous 3 months or issues of general interest. They can be submitted through the Web (www.submit2science.org) or by regular mail (1200 New York Ave., NW, Washington, DC 20005, USA). Letters are not acknowledged upon receipt, nor are authors generally consulted before publication. Whether published in full or in part, letters are subject to editing for clarity and space.

Bushmeat Hunting As Climate Threat

TROPICAL FORESTS STORE 340 BILLION TONS of carbon, equivalent to more than 40 years' worth of human fossil fuel emissions (*1*). Tropical deforestation and degradation are responsible for an estimated 20% of global carbon emissions to the atmosphere (*2*). In response, a new policy that aims to reduce emissions from deforestation and degradation (REDD) will likely be part of the climate treaty negotiated by the United Nations Framework Convention on Climate Change this December.

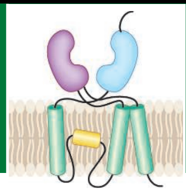
Meanwhile, overhunting is pushing many animals to extinction (*3*, *4*). Hunting rates in tropical Africa are more than six times greater than sustainable levels; large animals are already gone from most tropical Asian forests (*4*). Losses from overhunting are particularly severe among large-bodied animals because these species tend to be preferentially hunted and to have slower population growth rates (*5*).

This "bushmeat crisis" has received growing attention from vertebrate ecologists but is rarely considered by climate change scientists. Yet the two issues are linked: By removing the animal dispersers of carbon-rich tree seeds, hunting may be reducing the globally impor-



Packing polymers

374



Neurobiology prize essay

382

tant carbon sink provided by tropical forests. Many of the most carbon-dense tree species rely on large vertebrates to transport their seeds and ensure successful reproduction.

Recent work in hunted forests of Peru reveals a substantial shift in species composition as large-seeded trees are replaced by smaller-seeded species (*6*). Furthermore, several studies highlight a positive relationship between seed size and tree wood density (*7*, *8*). Wood density is among the best predictors of aboveground carbon storage in tropical forests (*9*, *10*). Simulations of species composition in Panama show that selective logging of trees with high wood density reduces forest carbon storage by a staggering 70% (*10*). We suggest that degradations of carbon storage can also be driven by overhunting, as large-seeded trees with high wood density are deprived of their seed-dispersing animals. Even forests whose trees received full protection from a program such as REDD could, over decades, lose carbon stocks through the ripple effects of bushmeat hunting on species interactions. Actions that shelter trees can also conserve certain smaller organisms, a phenomenon known as the "umbrella species effect." But this trickle-down protection does not extend to large-bodied vertebrates that are directly exploited. Mitigation strategies may help reduce deforestation emissions over the short term, but they must also conserve tropical animals in order to truly keep carbon on the ground into the future.

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Climate Engineering Vulnerable to Disruption

G. C. HEGERL AND S. SOLOMON ("RISKS OF climate engineering," Perspectives, 21 August, p. 955) point out that attempting to engineer climate by decreasing incoming sunlight carries serious risks to the planetary hydrological system. But another set of risks has not been seriously addressed and may be much more consequential. Over the long haul, any kind of climate engineering would have to be sustained, and indeed increased in intensity because of continued rise in greenhouse gas concentrations. Any extended disruption, even for a few years, could lead to catastrophically large and rapid climate variations. Disruptions could arise from any number of societal factors: financial meltdown, political upheaval, environmental disasters, war, or simply loss of interest by the funding public. If climate engineering is seriously considered, it will be necessary to carefully address the likelihood, impacts, and possible responses to such disruptions.

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Conserve Livestock Genetic Resources, Too

M. S. SWAMINATHAN ("GENE BANKS FOR A warming planet," Editorial, 31 July, p. 517) delivered a convincing argument for strengthening and expanding gene banks and other mechanisms for conservation of the biodiversity of agricultural plants, particularly in the context of climate change. This call to action should be echoed for animal genetic resources for food and agriculture. Similar to plants, animal genetic resources are being lost at an alarming rate. The Food and Agriculture Organization of the United Nations (*1*) has reported that at least 20% of existing livestock breeds risk extinction, with insufficient data on an additional 30%. Furthermore, largely due to the need for cryoconservation of animal germplasm when stored ex situ and the associated costs and technical expertise required, gene banks for livestock are relatively rare, especially in developing countries.

Although livestock contribute to climate change (*2*), they will also play an integral role in allowing mankind to withstand its effects. Certain breeds are adapted to marginal areas that are too dry or have other ecological features that render them inhospitable for other forms of agriculture. Other breeds are resistant to endemic diseases that may expand their territory as a result of climate change. The selection of these animals for survival in harsh environments rather than for high productivity has made them more valuable for the future but more vulnerable in the present economic conditions. Without conservation programs, the risk of losing the unique alleles and other genetic variations that underlie this adaptation is great. International collaboration is urgently needed to ensure their conservation.

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Teaching, Not Testing, for Scientific Vision

DAVID LUBINSKI AND CAMILLA BENBOW ARE certainly correct that "Science needs kids with vision" (C. Holden, News of the Week, 4 September, p. 1190), but I take issue with their position that we must therefore test visualization as a talent. Our group, too, has demonstrated that use of visualization skills in scientific problem-solving is directly correlated with success as a scientist (*1*), but we have also demonstrated that crafts and arts skills correlate just as highly (*2*). Crafts and arts skills also correlate very strongly with visualization ability (*1*, *3*). From these data, we conclude that visualization ability is not an innate talent, but a skill that anyone can learn through the practice of visual arts, crafts, and model building (*1*, *3*). In fact, numerous studies [e.g., (*4*–*7*)] show that science and engineering students who initially test poorly on visualization tests (many of them women) and are subsequently given mechanical or artistic drawing training improve dramatically on retest and perform better overall in their science and engineering coursework. So rather than wasting money using visual tests to search for "Edisons and Fords" overlooked by other standardized tests, I suggest teaching arts and crafts to improve the manipulative and visualization skills of all students (especially women), thereby enlarging the pool of potential innovators.

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CORRECTIONS AND CLARIFICATIONS

News of the Week: "Paper retracted following genome data breach" by C. Holden (18 September, p. 1486). Michael Miller is at the University of Minnesota in Minneapolis and not at the University of California, Santa Barbara.

News Focus: "A cure for euthanasia?" by D. Grimm (18 September, p. 1490). On page 1493, the statement "Briggs says ACC&D's lack of funding slowed U.S. Food and Drug Administration approval" should instead be "ACC&D's Briggs says lack of funding slowed U.S. Food and Drug Administration approval."

Brevia: "30,000-year-old wild flax fibers," by E. Kvavadze *et al*. (11 September, p. 1359). The fiber length unit of measure was incorrect. The correct sentence is "The complete fibers are long (>200 m) and composed of segments of smaller lengths."

Reports: "Regulation of histone acetylation in the nucleus by sphingosine-1-phosphate" by N.C. Hait *et al*. (4 September, p. 1254). In Fig. 4A, the second group of columns should be labeled "V5-SphK2," not "H3-K9achK2."

Reports: "Spectroscopic fingerprint of phase-incoherent superconductivity in the underdoped $Bi_2Sr_2CaCu_2O_{8+\delta}$" by J. Lee *et al*. (28 August, p. 1099). The title should have been "Spectroscopic fingerprint of phase-incoherent superconductivity in the cuprate pseudogap state."

Reports: "Coupling mechanics to charge transport in carbon nanotube mechanical resonators" by B. Lassagne *et al*. (28 August, p. 1107). The name of the fourth author was incorrect. It should be Daniel Garcia-Sanchez. The name has been corrected in the HTML version online.

Letters: "Creationists made me do it" by P. J. Keeling (21 August, p. 945). The book in the cartoon should have been titled "On the Origin of Species."

Reports: "A functional genomics approach reveals CHE as a component of the *Arabidopsis* circadian clock" by J. L. Pruneda-Paz *et al*. (13 March, p. 1481). In Fig. 3C, several bars at the right of the figure were missing. The corrected figure is shown here.