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SCIENCE

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THE MOLECULE OF THE YEAR

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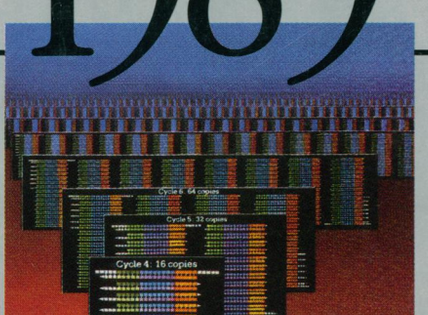

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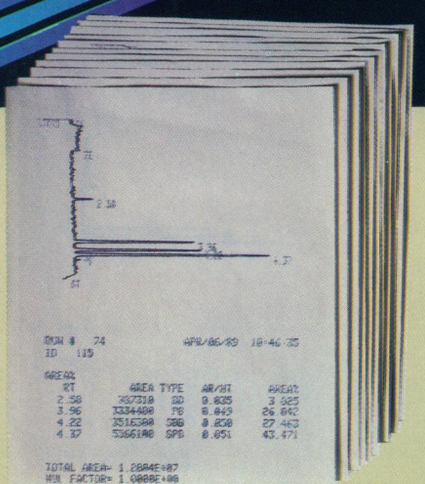

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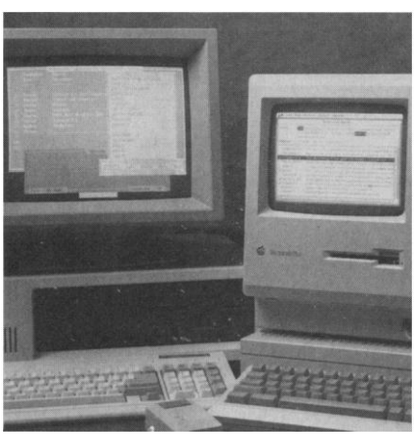

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SCIENCE

ISSN 0036-8075
22 DECEMBER 1989
VOLUME 246
NUMBER 4937

1539 This Week in *Science*

Editorial

1541 The Molecule of the Year

Perspective

1543 The Molecule of the Year: RUTH L. GUYER AND D. E. KOSHLAND, JR.

Letters

1547 U.S. Scientists and China: J. C. WANG ■ AIDS Drug Trials: R. SMITH ■ Leopard Habitat: D. P. ROSENBERG ■ Neuroscience at Washington University: C. C. HUNT ■ Information Policy: D. A. B. LINDBERG ■ Ethics and USGS: H. WILSHIRE; K. SCHAMBACH; E. MARSHALL

News & Comment

1551 Hubble: Great Telescope, Bad Service Plan
1553 Plea to Bromley: Save Our Neutrons
1554 Britain's Lords Debate Embryo Research
1555 Science and PR North of the Border
1556 Maine Case Deals Blow to DNA Fingerprinting

Research News

1559 New AIDS Drugs Take Careful Aim
1560 Is the AIDS Epidemic Slowing?
1561 Key Piece Found for Immunology Puzzle?
1562 Geophysics from Triton to the Deep Blue Sea: New Quake Forecast: North by Northwest ■ Loma Prieta Quake Unsettles Geophysicists ■ A Geologically Young Triton After All? ■ Bringing Down the Sea Level Rise
1564 *Briefings*: R&D Lobby Spends NSF's '91 Budget ■ AIDS Tests Fail ■ Study Puts Admiral Peary at North Pole ■ Global Change Encyclopedia on Disc ■ A Faster Parallel Computer for 1992 ■ Academy Recognizes Koop ■ Canadian Kludge? ■ Bromley OSTP Team at Full Strength? ■ George Mason U. Snares NSF's Moore ■ HUGO: Genome Data Open to Scientists

Articles

1566 Origins of Agriculture in Eastern North America: B. D. SMITH
1571 Quantifying the Information Content of Lattice Images: A. OURMAZD, D. W. TAYLOR, M. BODE, Y. KIM

Research Articles

1578 Specific Interactions in RNA Enzyme-Substrate Complexes: C. GUERRIER-TAKADA, N. LUMELSKY, S. ALTMAN

Reports

1585 Volatilization of High Molecular Weight DNA by Pulsed Laser Ablation of Frozen Aqueous Solutions: R. W. NELSON, M. J. RAINBOW *et al.*
1587 Growth of Greenland Ice Sheet: Measurement: H. J. ZWALLY, A. C. BRENNER, J. A. MAJOR, R. A. BINDSCHADLER, J. G. MARSH
1589 Growth of Greenland Ice Sheet: Interpretation: H. J. ZWALLY
1591 Thermomolecular Pressure in Surface Melting: Motivation for Frost Heave: J. G. DASH
1593 Air Ventilation by Recoil Aspiration in Polypterid Fishes: E. L. BRAINERD, K. F. LIEM, C. T. SAMPER
1595 The Anticodon Contains a Major Element of the Identity of Arginine Transfer RNAs: L. H. SCHULMAN AND H. PELKA

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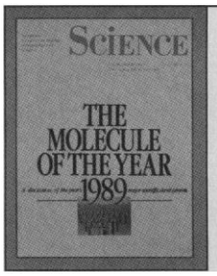

COVER Eighteen of 1989's top scientific achievements are discussed in a year-end wrap-up, and from this group the "Molecule of the Year" was chosen. The winner—an enzyme that drives a cyclic amplification reaction that produces millions of copies of interesting genes and gene segments. See pages 1541 and 1543. [Image by Lewis E. Calver, courtesy of Cetus Corporation, Emeryville, CA 94608]

1597 A Model of Human Acute Lymphoblastic Leukemia in Immune-Deficient SCID Mice: S. KAMEL-REID, M. LETARTE, C. SIRARD, M. DOEDENS *et al.*

1601 Endothelial Interleukin-8: A Novel Inhibitor of Leukocyte-Endothelial Interactions: M. A. GIMBRONE, JR., M. S. OBIN, A. F. BROCK *et al.*

1603 Conserved Repetitive Epitope Recognized by $CD4^+$ Clones from a Malaria-Immunized Volunteer: E. H. NARDIN, D. A. HERRINGTON, J. DAVIS *et al.*

1606 Inhibition of Antigen-Induced Lymphocyte Proliferation by Tat Protein from HIV-1: R. P. VISCIDI, K. MAYUR, H. M. LEDERMAN, A. D. FRANKEL

1608 Mechanisms for Regulating Expression of Membrane Isoforms of Fcγ RIII (CD16): M. L. HIBBS, P. SELVARAJ, O. CARPÉN, T. A. SPRINGER *et al.*

1611 Membrane Anchoring of a Human IgG Fc Receptor (CD16) Determined by a Single Amino Acid: L. L. LANIER, S. CWIRLA, G. YU, R. TESTI, J. H. PHILLIPS

1614 Immunodeficiency and Clonal Growth of Target Cells Induced by Helper-Free Defective Retrovirus: M. HUANG, C. SIMARD, P. JOLICOEUR

1617 Cyclosporin A Specifically Inhibits Function of Nuclear Proteins Involved in T Cell Activation: E. A. EMMEL, C. L. VERWEIJ, D. B. DURAND *et al.*

1620 Molecular Cloning of the Thyrotropin Receptor: M. PARMENTIER, F. LIBERT, C. MAENHAUT, A. LEFORT, C. GÉRARD, J. PERRET, J. VAN SANDE *et al.*

1622 Regulation of Proenkephalin by Fos and Jun: J. L. SONNENBERG, F. J. RAUSCHER III, J. I. MORGAN, T. CURRAN

1625 Functional Analysis of CAR, the Target Sequence for the Rev Protein of HIV-1: E. T. DAYTON, D. M. POWELL, A. I. DAYTON

1629 Differential Effects of *nef* on HIV Replication: Implications for Viral Pathogenesis in the Host: C. CHENG-MAYER, P. IANNELLO, K. SHAW, P. A. LUCIW, J. A. LEVY

1632 RNA Editing in Plant Mitochondria: R. HIESEL, B. WISSINGER, W. SCHUSTER, A. BRENNICKE

Technical Comments

1635 Steroid Binding at σ-"Opoid" Receptors: S. SCHWARZ, P. POHL, G.-Z. ZHOU; T.-P. SU, E. D. LONDON, J. H. JAFFE ■ Hydrolysis of Carbon Tetrachloride: P. M. JEFFERS AND N. L. WOLFE; D. W. R. WALLACE AND M. KRYSELL ■ Caterpillars and Polymorphisms: S. H. FAETH AND K. E. HAMMON; E. GREENE ■ Does Voltage Affect Excitation-Contraction Coupling in the Heart?: M. B. CANNELL, J. R. BERLIN, W. J. LEDERER; M. MORAD, L. CLEEMANN, G. CALLAWAERT

Book Reviews

1642 Made in America AND Working Papers of the MIT Commission on Industrial Productivity, *reviewed by* D. C. MOWERY ■ Beyond the Barricades, W. M. SULLIVAN ■ Ecology in the 20th Century, R. A. POIS ■ A Theory of Human and Primate Evolution, J. MARKS ■ Hypersaline Environments, W. D. GRANT ■ Treatise on Heavy-Ion Science, E. HAGBERG ■ Books Received

Products & Materials

1649 Program for Drawing Chemical Structures ■ Monoclonal Antibodies ■ Delivery System for Cell Injection ■ Plastic Slide Case ■ Data Acquisition and Analysis Software ■ Genome Qualified Restriction Enzymes ■ Literature

Author Index to Volume 246 is found on pages I–X.
Information for Contributors is found on XI–XII.

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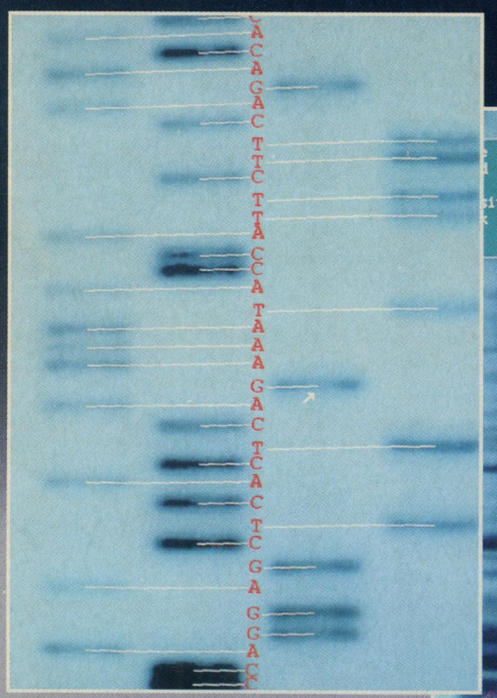
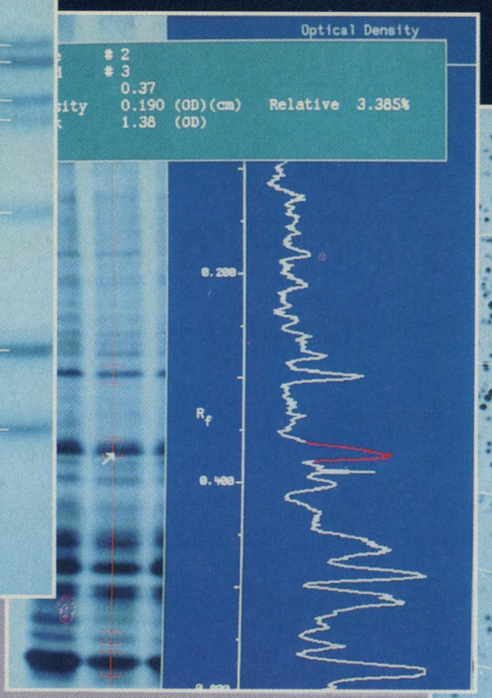
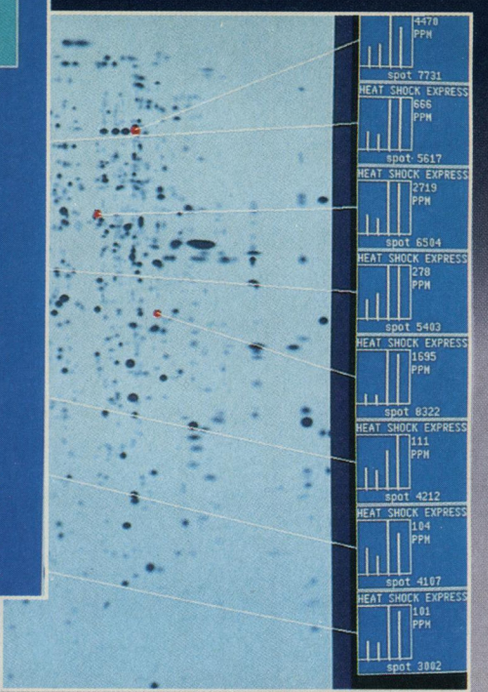


DNA Sequence Reading



1-D Gel Quantitation



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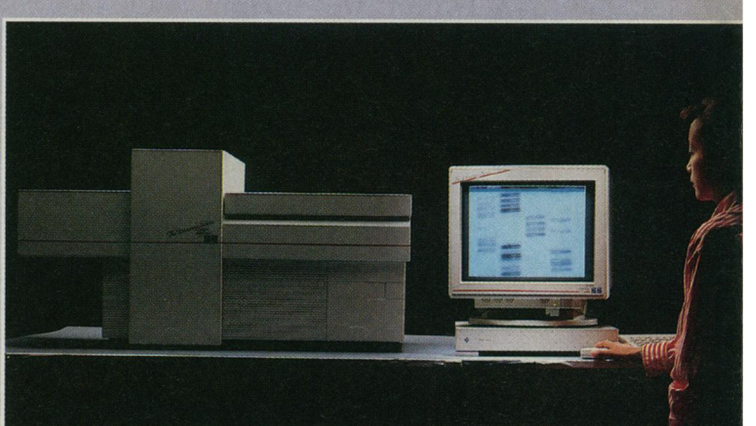

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Origins of agriculture

As humans progress from foragers to farmers, three important transitions occur in their relations with plant foods: once wild plants are domesticated, a food-producing economy comes into being, and production focuses on a small number of crops. In eastern North America, these milestones in human-plant relations were reached centuries apart (page 1566). The first indications that humans were intervening in plant life cycles appear between 2000 and 1000 B.C.: morphologic signs in seed specimens suggest that a form of squash, a sunflower, and two other plant crops had been domesticated. Later, between 250 B.C. and A.D. 200, the trend toward food-producing economies became widespread. And, between A.D. 800 and 1100, when complex sociopolitical changes were taking place, maize was introduced from tropical regions and became the major crop and food. This history, presented by Smith, represents a synthesis of information from the archeologic record and from measurements (with new techniques) of ages and characteristics of seed samples, human bones, artifacts, and other relevant materials. The work firmly establishes eastern North America as an independent center of plant domestication.

Thickening Greenland ice sheet

CHANGES in the volume of ice stored on continental ice sheets greatly affect global sea level because the sheets are so massive. Satellite radar measurements now indicate that the Greenland ice sheet south of 72°N has been thickening by about 0.23 meter/year since 1975 (pages 1587 and 1589). The measurements of ice surface elevation were made with altimeters on three satellites; elevation changes were calculated from comparisons of data obtained during different orbits. Depending on whether the ice sheet north of 72°N is also thickening and whether thickening is a recent or long-term phenomenon, the mass increase could correspond to falls in global sea level of 0.2 to 0.7 millimeter/year. Zwally discusses how ice sheet mass, sea level, and climate are related: over the short term, global warming could produce more precipitation and greater ice accumulations at Greenland and Antarctica and thus a drop in sea level; over longer periods, however, the dynamic response of the glaciers to warmer temperatures and increased precipitation is less clear, and sea-level rises could occur if the glaciers start flowing faster.

Recoil aspiration

AMPHIBIANS and air-breathing nonpolypterid fishes breathe by pulse pumping: the buccal cavity of the mouth fills with air, and when the mouth is closed air is forced into the lungs. In contrast, birds, mammals, and reptiles breathe by aspiration: their lungs expand first and air is then sucked in. Although primitive air-breathing polypterid fishes lack the structures thought to be essential for aspiration (diaphragms and movable ribs), they too have been found to breathe by a form of aspiration (page 1593). High-speed x-ray pictures of mouths and lungs and measurements of air pressure in the fishes' pleuroperitoneal cavities show that air is exhaled when the bony-scaled "jacket" or integument actively deforms and is inhaled as the integument passively recoils. Brainerd *et al.* note that recoil aspiration may have been used by the earliest amphibians, who, like their air-breathing fish ancestors and the polypterid fishes, had ventral bony scales.

SCID mice and childhood leukemia

A system for evaluating the progression of acute lymphoblastic leukemia, the most prevalent form of leukemia in children, has been devised by Kamel-Reid *et al.* (page 1597). When cultured cells derived from a leukemic child were injected into SCID mice (mice with severe combined immune-deficiency disease), the cells first grew in the bone marrow and later spread to the spleen, liver, and kidneys, just as they do in diseased children. As disease advanced, and again in keeping with the human pattern, the leukemic cells metastasized to the mouse's brain, lungs, intestines, and pancreas. If indeed the pattern of tumor cell differentiation and metastasis in mice is faithful to that in children, the SCID mice could become valuable adjuncts in the management of individual cases of leukemia. The course of disease in a child might be predicted from its course in the mice, treatment protocols could be evaluated in mice, and the success of chemotherapies could be determined by injecting patient's cells into mice and searching for growth of tumor cells.

RNA editing

Is the evening primrose using a nonstandard genetic code or is it doing some unusual editing of its RNA? The question arose as a result of observations by Hiesel *et al.* that there was not exact correspondence between the sequences of nucleotides in certain mitochondrial genes and in the complementary DNA molecules patterned on messenger RNA molecules made from those genes (page 1632). Specifically, the nucleotide cytosine (C) in the genes was frequently represented by thymidine (T) in complementary DNA molecules; had editing not occurred, the sequences of the complementary DNA and the DNA of the gene should have been identical. The replacements of some (but not all) of the Cs by Ts were found not only in the coding regions of the genes but also in those parts of the genes that do not get translated; the rate of such exchanges was about 1 in 58 nucleotides. The changes in the coding region were not silent but led to the insertion of different amino acids in the protein products; interestingly, the affected amino acids were ones that proved to be highly conserved in evolution. How the editing occurs (perhaps through some chemical modification) and whether it is a common or an unusual phenomenon remain to be determined. ■ RUTH LEVY GUYER

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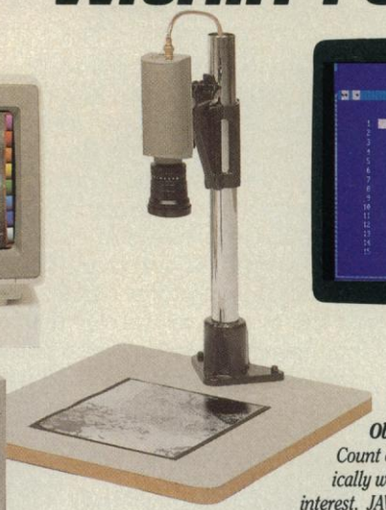

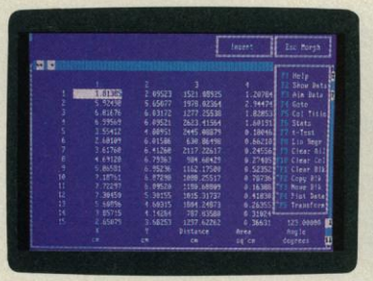

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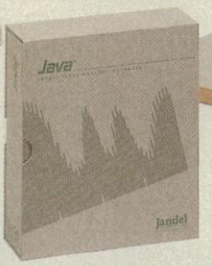

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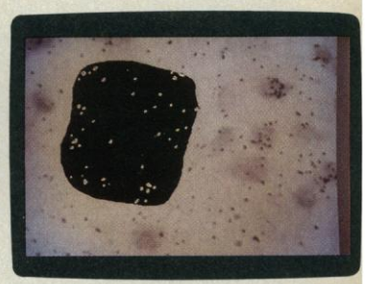

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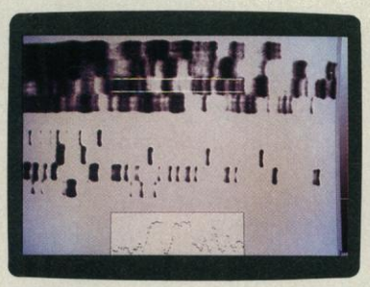

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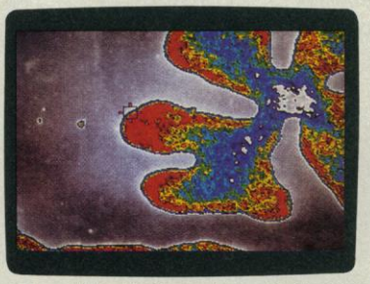

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The Molecule of the Year

Historians tend to personalize history. They use political leaders to symbolize war or peace, freedom or slavery, abundance or starvation. Political systems represented by these individuals may be essential, but political leaders cannot cure disease without medicine, cannot improve crops without fertilizer, and cannot encourage the literacy on which democracy depends without communications technology. The great advances of the past have been profoundly influenced by science and technology, and our present standard of living depends on them. Political systems can be designed to encourage advances in science and are essential to the fair distribution of its products. Wealth must be created before it can be distributed.

Sometimes, in the rush of daily events and the ease of describing personalities instead of analyzing issues, the fundamental causes of progress can be obscured. To symbolize that scientific progress and to honor the structure that creates it, *Science* has decided to name a Molecule of the Year. The molecule will symbolize a discovery or technique that may actually involve many molecules, but the award will be singular to force us to choose one such discovery each year that is likely to have the greatest influence on history. We will not require that the initial discovery has to be made in the year of the award because many discoveries are not recognized immediately or require refinement for optimum value. The award will, however, reflect the fact that the particular discovery has reached in the year of the award a stage of development and understanding sufficient to establish its long-term significance.

This year's award goes to the DNA polymerase molecule and to the technique called polymerase chain reaction. PCR, as it is called, has developed into one of the most powerful tools of modern biology since its discovery several years ago, and its applications are burgeoning. One of its first applications allowed an Indian mother to establish the identity of her son for immigration purposes. It has this year served as the basis for making human antibodies in a bacterium. It is revolutionizing the approaches researchers are taking to many problems in biology. Other properties and potentials of PCR are discussed in the section that follows, as are many other discoveries that could easily have been chosen in a year that has seen major advances of science in almost every discipline.

Some who look into the mirror darkly see the waste disposal problem and forget the great numbers of people alive today, see the pesticide problem and forget the availability of food to many, or see the acid rain problem and forget the popularity of the automobile. Each widely adopted technical advance generates new problems that themselves cry out for technical solutions. The problems are real. So, is this progress?

To answer that question I propose a simple objective test: the era swap experiment. Each person could choose to be transported back to some previous time but only on condition that he or she adopt all the features and restrictions of that era. In the 1800s, for example, the globe was less crowded, the air was clearer, the water cleaner, and there were no plastics. However, life expectancy was half of what it is today, transportation was by horseback or on foot, and medical operations were performed without anesthetics. Even a few years ago a high proportion of women died in childbirth, and pneumonia was one of the major causes of death for middle-aged people. Faced with such realities, who would choose to live even a few years in the past?

Our Molecule of the Year is a symbol that we are honoring the process of progress rather than a personality. Most of the discoveries of science (and probably much of political history) result from the actions of many individuals, one of whom may contribute slightly more than others. Each person who moves the discovery one step further contributes to the benefit of all. Science is an international enterprise; its practitioners and those who benefit from the knowledge it creates are located throughout the world. The new knowledge—which translates into living standards—can be used for good or evil, can be distributed fairly or unfairly. The challenge to science is to generate the new discoveries. The challenge to society is to use those discoveries for the betterment of all.—DANIEL E. KOSHLAND, JR.

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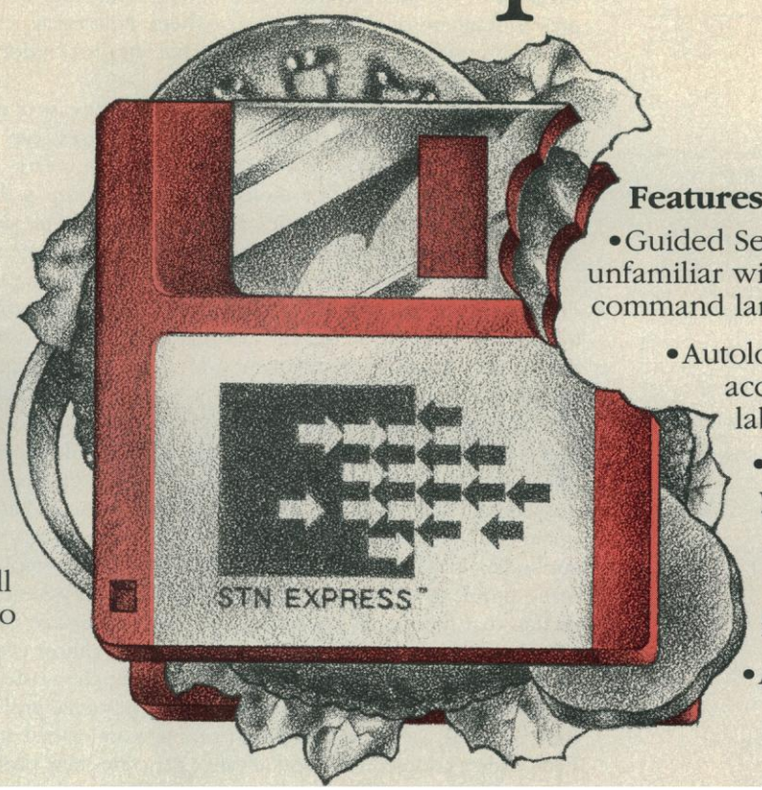

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I find puzzling Atkinson's assertion that the NLM does not have a "wide distribution" mechanism in place. The fact that there are more than 30,000 individuals and organizations, including the libraries at his institution, who regularly search the more than 12 million records in the NLM's databases would argue otherwise. The 4 million searches each year of files at NLM, the like number of searches of NLM files on commercial information vendors, the 42 medical schools and hospitals who mount NLM subsets, 16 overseas partners, and the nine licensed commercial CD-ROM Medline products also bespeak our having made at least a start at "wide distribution" of records of the periodical literature.

With respect to catalog records for books, NLM provides online services to users and also serves the general library community by means of the data it provides through tapes. The latter has proven an efficacious route over the years, since medical books per se constitute only a small percentage of the books acquired by a general or university library. Thus, NLM's cataloging data are made available to bibliographic utilities such as the Research Libraries Information Network, the Western Library Network, the Online Computer Library Center (OCLC), and to companies that produce and distribute CD-ROM's. The arrangement of longest standing, with OCLC, has been in existence for more than 20 years. In fact, it has been estimated that more than $3.5 million is saved each year by medical libraries in the United States who use NLM cataloging data from a variety of sources and are thus freed from the expense and labor of doing their own cataloging of the medical literature.

The implication that NLM seeks to solve a "budget crunch" by charging fees that are higher than access or reproduction costs is not correct. The scientific community should know that any fee collections above the costs of access, as in the case of foreign use, are not used by the NLM, but are returned to the U.S. treasury.

DONALD A. B. LINDBERG
Director, National Library of Medicine, Bethesda, MD 20894

Ethics and USGS

Eliot Marshall's commentary on the ethics debate at the U.S. Geological Survey (USGS) (News & Comment, 3 Nov, p. 570) sheds welcome light on some of the on-going issues, but inevitably included factual errors. Here I attempt to correct the more important ones and to emphasize the fundamental issues as I see them.

Contrary to statements in the article, I was not acting as an adviser to Friends Aware of Wildlife Needs (FAWN), nor is it true that "Wilshire at one point suggested that FAWN subpoena him as a USGS expert, even though federal employees are not allowed to testify as experts against the government." Government employees can testify in such cases, with appropriate clearance.

My role in the El Dorado National Forest plan for off-road vehicle development was independent of FAWN and began with my review (as a private citizen) of the U.S. Forest Service's environmental assessment. Much later FAWN president Karen Schambach invited me to see the site. I walked around the area with Schambach on my own time on a Sunday afternoon. I made no measurements and took no notes, but this was later characterized by Dallas Peck as a "survey" made for FAWN in violation of the USGS Organic Act. Subsequently, FAWN requested my testimony, and in response I consulted appropriate USGS officials about the procedures FAWN would be required to follow. USGS instructed FAWN to subpoena me if they wanted my testimony. At no time did I suggest to FAWN that I be subpoened.

Marshall's article states that the Administrative Digest (AD) 993, which caused so much furor last summer, "was later withdrawn and general advice to use 'sound judgment' " was given. AD 993 was amended, not withdrawn (as of 15 November 1989 it was issued to new employees). The Zen committee product (AD 1009) modified AD 993's blanket proscription of all private activities related to USGS functions only by giving explicit permission to participate in professional society activities.

Another issue highlighted in Marshall's article relates to "advocacy." Peck has recently stated the USGS position in a letter to James Gutmann at Wesleyan University: "Presentation and interpretation of research results *in the furtherance of a position taken by a public interest group in a matter of dispute* is advocacy" (emphasis in original). When a USGS scientist presents and interprets research results in the furtherance of the government's position, it is considered "objective scientific support," but when the same scientist presents and interprets objective scientific results which happen to contradict the government's position, it suddenly becomes prohibited advocacy. Surely such an official policy does more to undermine the integrity and impartiality of the USGS than anything any individual scientist could ever say or do.

The FAWN case has resolved only the narrow issue that there was no evidence to support the charges against me. The broader issues that remain unresolved are (i) the present USGS administration's attempt to use the Organic Act to deny information and the expertise of federal scientists to public-interest groups when environmental policy is in dispute; (ii) the continued threat in AD 993 of unconstitutional infringements of employee's private activities and suppression of free speech; and (iii) violation of the principles of due process and equal treatment under the law through unequal applications of the Organic Act's prohibitions against executing surveys and examinations. It is hard to escape the conclusion that the selective application of the Organic Act is politically motivated.

The oath of office sworn by all USGS employees is that we will support and defend the Constitution of the United States. The credibility of USGS, in my opinion, is best maintained by honoring that oath and not by suppressing the freedoms granted by the Constitution to satisfy the transient political aims of any particular administration.

HOWARD WILSHIRE
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Eliot Marshall's article about Howard Wilshire was a welcome exposure of a dark side of government. Two items, however, need clarification.

At no time did FAWN ask Wilshire's advice on "how to prevent the Forest Service from building a playground for motorcyclists." FAWN already had very competent legal counsel. Wilshire's role was limited to addressing, independently, the soils section of an environmental assessment prepared by the U.S. Forest Service for the project.

At my invitation, he subsequently visited the site of the proposed project. When we asked him to testify at a court hearing, Wilshire responded that we must go through USGS channels to obtain his testimony, even as a private citizen.

It was Wilshire's superiors who described a subpoena as the proper way to proceed. And it was the U.S. Attorney (who represents the Forest Service in this case) who insisted he testify as a government employee, because restrictions could then be placed on his testimony.

The "resolution" of the Wilshire case leaves unanswered two big questions: First, can a public interest group (and the public) be denied access to the expertise, gained at public expense, of government scientists, when that expertise does not further the political goals of the government?

Second is the constitutional issue: Can government scientists be denied the right to speak as private citizens on politically hot subjects?

Standing on its own, it is tough to swallow the USGS's concern for its credibility as the motive for Wilshire's harassment. But Forest Service attempts to silence a Fish and Game biologist who was also to testify at that hearing, and their threat of a boycott of my employer's small business, which brought about my own dismissal (the three incidents all occurred within 2 weeks of the court hearing), make it unlikely the action against Wilshire was anything but an attempt to crush scientific dissent.

FAWN ultimately won its suit. The weakness of the government's defense of the dirt bike project explains their reliance on eliminating FAWN's witnesses.

KAREN SCHAMBACH
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Response: Wilshire was not an adviser to FAWN, but he did meet with FAWN's president, Karen Schambach, toured the disputed Rock Creek area with her, and spoke with FAWN's attorney Sharon Duggan about the impending lawsuit. When Duggan asked him for an affidavit, Wilshire responded that he would have to get clearance—whether to testify as a private citizen or as a USGS employee—and that FAWN would have to submit a formal request for his testimony. In explaining this to Duggan, Wilshire's attorney has written, Wilshire "noted that he believed his testimony would carry more weight as a USGS employee . . . . ." FAWN later subpoenaed Wilshire as a percipient (not an expert) witness, but never asked him to testify.

As for the status of Administrative Digest 993, USGS personnel chief Maxine Willard informed *Science* that the relevant section has been "withdrawn" and is considered void.

—ELIOT MARSHALL

Erratum: In the caption of figure 2 (p. 1401) of the article "Ferroelectric memories" by James F. Scott and Carlos A. Paz de Araujo (15 Dec., p. 1400), the credit should have read, "[Figure reproduced by permission of Raymond Fedorak, Naval Air Defense Command]."

Erratum: In the News & Comment article by Marjorie Sun "Investors' yen for U.S. technology" (8 Dec., p. 1238), the name of the computer company Poqet Computer Corporation was misspelled.

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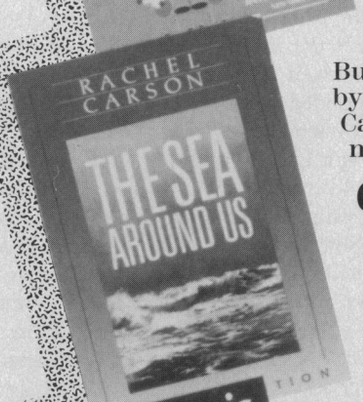

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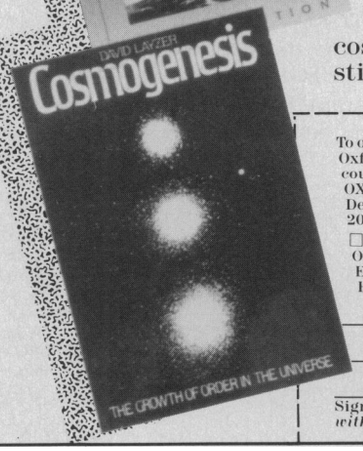

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