Education

Training developing-country nationals is the critical ingredient to conserving global biodiversity

by Chris Wemmer, Rasanayagam Rudran, Francisco Dallmeier, and Don E. Wilson

Growing awareness of global change has hastened a range of responses by international bodies, governmental agencies, and nongovernmental organizations concerned with biological conservation. A paucity of qualified personnel in many developing countries has frustrated the implementation of foreign technical assistance, particularly in the environmental conservation sphere (Adams and McShane 1992). Many developing-country nationals attend North American universities, but natural science is not the preferred curriculum. Ironically, the greatest challenges to the developing world are environmental and will ultimately require solutions based on biological knowledge of tropical ecosystems (Robinson 1989, 1992).

One of the nation's oldest scientific institutions is providing one response: specialized technological training for growing numbers of students and professionals in developing countries. Founded in 1946 "for the increase and diffusion of knowledge among men," the Smithsonian Institution comprises the world's largest assemblage of cultural and scientific collections dedicated to public exhibition and scientific research. In management and organization, the institution is unique. Established at the bequest of James Smithson, it has proudly defended its hybrid legal status as a semifederal trust instrumentality to avoid the bureaucratic conventions that characterize most government organizations (Harrison 1972), and it enjoys the benefits of both federal and private funding to conduct cultural and scientific programs.

For many years, the institution has offered educational opportunities to individual scientists and scholars through its fellowship programs, and over the years these opportunities have increased in scope and audience to address a growing demand. Although many recipients of these awards have been foreign nationals, specific initiatives for training biologists of less-affluent nations were not developed until the 1980s. Since then, the conservation of biological diversity has become an institutional theme and has evolved into a series of complementary global initiatives with a concentration on Latin America and Asia. With mounting awareness of the consequences of global change occasioned by the destruction of the tropical greenbelt, these programs are still evolving new ways of addressing the problem through training and education.

The International Union for the Conservation of Nature's World Conservation Strategy (1980) was the first attempt to clarify and integrate conservation goals with human needs on a global scale. Although it acknowledged the urgent needs to conserve tropical ecosystems, it also called for immediate and concerted action of all nations and identified three areas of high priority: the establishment of protected areas, public education, and the training of conservation personnel in tropical countries. These same critical areas were emphatically reiterated in the US Strategy on the Conservation of Biological Diversity (US Interagency Task Force 1985), and further moves to redress the problem were attempted at the United Nations Conference on Environment and Development in Rio de Janeiro in 1992.

Resources, time, and trained personnel to implement programs in all three critical areas are beyond the scope of any one body. Protected-area management has been the major focus of funding by international aid-giving organizations in recent years. The skills and experience needed for research, policy development, land-use planning decisions, and management of protected areas can be secured only through education, which also happens to be the most cost-effective and immediate means of promoting biodiversity conservation. Without trained conservation personnel and heightened public awareness in tropical countries, efforts to protect natural habitats rarely get beyond the planning stage (Rudran et al. 1990). Our premise at the Smithsonian is that educated personnel are the essential catalyst to establish and maintain protected areas, to implement public education programs, and to use scientific research to understand ecosystem complexities. Given the urgency of averting widespread environmental disaster, several personnel training programs have been developed in recent years, and the demand for them has increased annually.

The National Zoo's program in biological conservation

The Smithsonian Institution's first conservation training program was developed by the National Zoological Park in 1980 in response to a request for a curriculum in primate population censusing and ecology by the National Institutes of Health (NIH). Spurred by the biomedical community's concern over export restrictions imposed on wild primates and the lack of data on the status of wild populations, NIH funded the Smithsonian to develop a training program on methods for the ecological investigation of primates. Primate ecologist R. Rudran was contracted to develop the curriculum.

The first course was given in 1981 to a class of seven, representing five countries, using the zoo's Conservation and Research Center (CRC) in

Front Royal, Virginia, as a base. At the same time, NIH, the Smithsonian, and several other agencies supported the preparation and publication of a field techniques manual for primates (CNP 1981). The training program evolved into a ten-week wildlife conservation and management training course, offered annually at CRC to 20–22 developing-country nationals.

In 1982, a second course was held overseas in Argentina. Since then, 18 courses have been held in 35 countries, including China, Indonesia, Sri Lanka, Peru, Malaysia, Venezuela, and Brazil. A total of 435 biologists, administrators, teachers, and nongovernmental organization employees has participated in the US and foreign courses since their inception.

African and Asian course participants learn methods, such as the fecal pellet group technique, that they can apply to field situations in their native countries. Photos: National Zoological Park.

Zoo biology training

In 1987, a zoo biology and animal management training course for zoo managers from developing countries was inaugurated with a seed grant from the Smithsonian's International Directorate. The course was conceived in response to requests for instruction in the management of wild animals in captivity and in recognition of the largely unrealized educational and scientific potential of zoos in the developing world (Robinson 1989, 1992, Wemmer et al. 1990). This resource is particularly important in countries of great biological diversity where there is a steady flow of endangered species into zoos, where opportunities for environmental education are minimal, and where animals in captivity usually perish without contributing to biological knowledge.

The program targets mid-level zoo managers, such as curators, biologists, biotechnicians, and veterinarians, and it is presented at foreign zoos by an instruction team of three to six zoo professionals from western and developing countries. Lasting two to three weeks, it emphasizes animal husbandry and education. It uses a manual developed specifically for the program that has been translated into Chinese, Bahasa Indonesia, Spanish, and French. To meet program demand and increase international awareness among zoo biologists, instructors have been recruited from more than 12 North American and European zoological parks. Many of these zoos have contributed funds to support their curator's participation in the program.

Microcomputer applications in wildlife ecology

One early lesson that emerged from these training programs was that although the wildlife departments of many developing countries had routinely collected information during wildlife and habitat surveys, the data were not always fully analyzed, properly archived, or published. For example, over the years the Bombay Natural History Society (BNHS) has supported a series of ambitious studies of Indian birds and more recently has pursued several ecological studies of the Asian elephant with support from the US Fish and Wildlife Service (FWS).

In 1989, to help analyze and publish the wildlife data, the BNHS requested assistance from FWS and the Smithsonian for training BNHS wildlife ecology researchers employed by this century-old nongovernmental organization to use microcomputers. A two-week workshop on microcomputer applications for wildlife research was funded and delivered by the FWS foreign currency program; the curriculum was planned by zoologist Michael Stüwe of the Smithsonian and biostatistician John Cary of the University of Wisconsin. A second workshop was presented in 1990, concentrating on geographical analyses of habitat and animal movements.

Other microcomputer workshops have been presented to the Malaysian Department of Wildlife and National Parks and to the Sri Lankan Department of Wildlife Conservation. The workshops have included topics such as geographical analyses of habitat and animal movements and general computer applications. In addition, a major international workshop was conducted in Rome during the 1989 International Theriological Conference.

Man and Biosphere Biological Diversity Program

The Smithsonian's Man and Biosphere Biological Diversity Program (SI/MAB) was created by the Smithsonian in 1986 in cooperation with the UNESCO-MAB Program. The biological diversity program had four goals: fostering international links among resource managers from the United States and tropical countries, developing and providing training in biodiversity research methods for biosphere reserves and other fragile or endangered areas, providing professional training in conservation of bio-

logical diversity and in wildlife and wildlands management in developing countries, and generating educational modules in local languages that can be used to support the first three goals.

Since 1987, 14 field workshops have been conducted in host countries. In addition, a museum workshop was held in Washington, DC, and a special workshop to evaluate the permanent plot methodology in use in many tropical biosphere reserves was conducted at the Smokey Mountain Biosphere Reserve in North Carolina.

Field workshops are taught by a multidisciplinary team of local, regional, and international instructors, normally to 18–23 host-country participants and 5–7 participants from neighboring countries. The original courses in 1987 concentrated on intensive permanent plot work for biological diversity research (Dallmeier et al. 1991, 1992). Since then, the curriculum has focused more intensively on biological diversity conservation and wildlife and wildland management. All course participants since 1989 have received university credits through a limited number of affiliated host-country universities.

Two major educational modules in wildland and wildlife management have been prepared, both in Spanish and Portuguese. In 1992, these modules were used to teach two courses to train host-country instructors.

National Museum of Natural History biodiversity programs

The Biological Diversity of Latin America Program (BIOLAT), initiated by Terry Erwin and currently directed by Don Wilson and Marsha Sitnik, conducts training courses on field methods for measuring biodiversity. Since 1987, the program has held six workshops in Bolivia and Peru, providing training to 250 participants. BIOLAT also supports research into all aspects of biological diversity, including carrying out inventories and monitoring flora and fauna in multidisciplinary ways, using permanent field stations in Peru (Pakitza-Manu National Park) and Bolivia (Beni Biological Reserve). Students and scholars who have completed the training course are eligible for continued support through small grants provided by the program.

BIOLAT is currently sponsoring a series of professional workshops designed to produce manuals of field methods for studying biodiversity, under the editorship of Mercedes Foster. The first of these, *Measuring and Monitoring Biological Diversity: Standard Methods for Amphibians* (Heyer et al. 1993) is scheduled to appear this year. The ultimate goal is a trained cadre of workers throughout the developing world capable of maintaining biodiversity inventory work in the future.

The training courses administered by the Office of Biodiversity Programs serve as an initial step in a hierarchy that continues support for the top performers in each group. On completion of a training course, the students are eligible to compete for junior investigator grants that allow them to continue studies as a part of a team headed by an established investigator. Those successfully completing the internship are then eligible for regular research grants from the program.

The Biological Dynamics of Forest Fragments Project, coordinated by Rob Bierregaard of the Smithsonian and Angelo dos Santos of the Organization for Sustainable Development, focuses on the changes wrought by human development and encroachment on the Amazonian rainforest ecosystem of Brazil. Instigated by Thomas Lovejoy in 1978 under the auspices of the World Wildlife Fund (WWF), graduate and postgraduate researchers inventory flora and fauna and measure soil moisture and physical changes in understory microclimate and in a series of isolated forest reserves near Manaus (Lovejoy and Bierregaard 1990, Lovejoy et al. 1989). The resulting analyses compare biotic and physical change, including the rate of loss of species, in different-sized reserves. They are expected to provide guidelines for the integration of conservation and economic development (Bierregaard et al. 1992, Lovejoy and Schubart 1989).

This large-scale natural experiment in Brazil also provides an ideal setting for education and training efforts. In addition to local classes from the National Institute for Research in Amazonia, the project has provided support for 12 doctoral students, 18 masters students, and more than 150 student interns since its inception in 1978. More than half of these students were Brazilian, and the remainder came from other Latin American countries, Europe, Africa, North America, and Australia.

The Caribbean Coral Reef Ecosystems Project was established in 1972 as a means of promoting coral reef and mangrove research by Smithsonian scientists and foreign investigators. Since 1972, a modest facility of three buildings at Carrie Bow Cay, Belize, has been the site for studies of biodiversity, food chain ecology, nutrient cycling, ecophysiology, and habitat mapping using satellite imagery. Although the station can house only 8 persons at a time, as many as 90 scientists have used the facility each year.

In 1991, the Belizean Ministry of Fisheries requested technical assistance in training from the United States Agency for International Development (USAID), and the Smithsonian was requested to provide the instruction. The first training program was conducted in June 1992, when 22 Belizean high school biology teachers and administrators received instruction, teaching aids, and materials on mangrove ecology. The ultimate goal of the program is to inform the general public on the vulnerability and relevance of mangroves to the individual Belizean's wellbeing and the country's long-term prosperity. In the future, this training program is to be expanded to other teachers and groups.

Demography of participants

More than 1000 trainees have participated in the above-mentioned programs, representing 62 developing countries. Because of differing disciplinary emphases, the composition of the student body differs among programs, ranging from government organizations to universities. The participants of the SI/MAB program come from nongovernmental organizations to a greater extent than do participants in other programs. The majority of participants in all the programs have a bachelor's degree or equivalent, and many students have a master's degree.

Latin American students constitute nearly 60% of the participants, whereas African students represent

only 5%. This imbalance is being rectified; USAID recently provided funds for two wildlife conservation and management training courses in Tanzania.

Institutional consolidation of programs

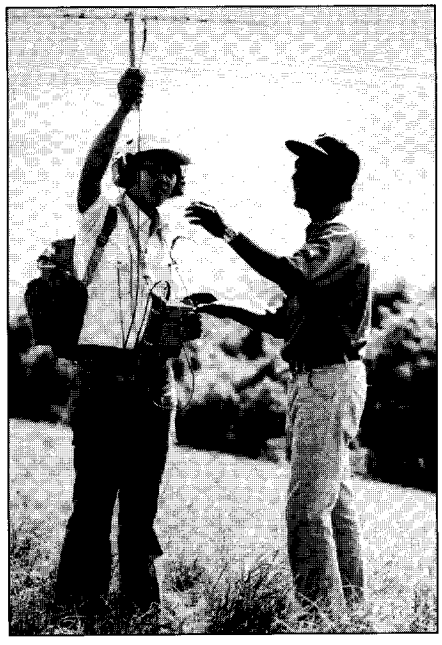
Until 1990, training programs were independently coordinated at the level of individual bureaus within the Smithsonian. In spite of overall congenial relations among course organizers, however, granting agencies, nongovernmental organizations, and prospective students did not appreciate the collective strength of the Smithsonian's different programs.

The result was the establishment of the Smithsonian Institution Conservation Training Council, which consists of the scientists responsible for the individual programs; the assistant secretaries for science and for external affairs serve as ex-officio members. As an ad-hoc group, the council crosses traditional bureau boundaries to expedite coordination of the various programs into a more focused and complementary approach. The results have been beneficial in promoting harmony in the pursuit of funds for all programs and in responding to emerging opportunities and needs. The council also has produced a training information brochure intended for prospective students.

Program evaluation

Measuring a program's effectiveness can be an elusive exercise and often receives little attention among conservation organizations, which tend to equate financial investment with project significance and assumed benefits. The difficulty of assessing the effectiveness of many conservation programs arises in part from the long-term nature of the goals. The ultimate educational goals of training, for example, cannot be appraised until the trained subjects reach a critical mass within a region and their influence can be brought to bear on environmental issues. The proximate educational goals, however, can be measured in the ability of the students to apply new information to solution of immediate problems.

A variety of methods has been independently employed to assess training program effectiveness. Student questionnaires have been collected at the end of most courses to gather information on what subjects were most and least useful, but these questionnaires often yield uncritical and humble declarations of gratitude for everything presented. The zoo biology course uses a series of quizzes to gauge class knowledge and, to assess mastery of material, uses problem-solving exercises involving competitive teams.



Rudy Rudran instructs Indonesian wildlife biologist Widodo Ramono in the use of radiotelemetry, a technique for investigating large-mammal ecology.

The desire to evaluate the Wildlife Conservation and Management Program precipitated a survey in 1991 to update information on past trainees and to provide means of assessing course content (Miquelle 1992). Of 448 participants who were sent mailings, 39% responded; based on information available on past participants, the sample was judged to be representative of the overall group. A survey of past participants revealed that more than 70% of the respondents work for government agencies, research facilities, or universities and thus are in positions to influence policy and decision making. Because more than 60% of the respondents have academic and public education positions, a multiplier effect of the training seems assured.

Field research methods, animal population and habitat management, and project coordination and administration were the topics ranked of highest interest among the curricula, and these topics correspond favorably with the participants' duties in their jobs. Of the respondents, 46% had published research papers in either regional or peer-reviewed journals and 18% had gone on to receive a graduate academic degree since finishing the course.

A comprehensive evaluation of the 1989 SI/MAB biodiversity field workshops was conducted as a masters project (Ulloa 1990). Using standard evaluation methodology, course logistics and students' attitudes and knowledge gain were assessed. Appropriate modifications in the curriculum and teaching program were made, and all subsequent courses have been assessed using the methodology.

International and regional centers for conservation

The ability of developing countries to conserve biodiversity without depending on foreign assistance is perhaps the single most critical and complex challenge of the global environmental dilemma. Discussions of the problem and prescriptions for its solution abound in the conservation literature, but proven mechanisms are scarce. The institution has assisted several countries in developing centers for biological conservation. The goals of these centers are to develop local capacity for professional training of conservation workers on a national, regional, or even international basis, and to impart to conservation workers and decision makers the analytical skills to examine environmental issues critically and to resolve them.

By facilitating links among existing organizations vested with environmental responsibility, the Smithsonian's role in the process has been catalytic and advisory. Developing countries differ greatly in the role that universities, government agencies, and nongovernmental organizations play in environmental protection, education, and management. To a great extent, the character and activities of a center are determined by local interests, but collaboration with the institution has clearly influenced the out-

come. Two of the centers are described below.

The Guianas. The Biodiversity of the Guianas Program, centered in Georgetown, Guyana, was conceived by Vicki Funk of the Smithsonian and Jane McKnight (then of WWF-US) as a regional program to combine science, education, and conservation in the Guyana Shield area. When the institution initiated botanical investigations in Guyana in 1983, it found an absence of nongovernmental organizations and scientific projects, but an air of receptivity prevailed toward foreign research. The project germinated as a botanical collecting initiative in 1984, but it quickly evolved into the current program, which inventories the flora and fauna of one of the most poorly known biotic regions of South America. The collaborative relationship between the institution and the government of Guyana is articulated in a memorandum of understanding signed with the University of Guyana in 1989.

In addition to conducting workshops and training local biologists in biodiversity documentation, the project forms part of a multinational effort that is documenting and publishing a comprehensive flora of the Guianas (Guyana, Surinam, and French Guyana; Boggin et al. 1992). Curatorial workshops held in the National Museum of Natural History's Department of Botany are helping to train Latin American herbarium workers in the preparation and maintenance of botanical specimens. The Royal Bank of Canada financed construction of the Center for the Study of Biological Diversity at the University of Guyana in Georgetown, and the National Museum of Natural History subsidizes the center to train Guyanese students and biologists in field techniques. Three technical committees of Guyanese and Smithsonian biologists have been formed to advise the government on research and conservation policy.

Malaysia. In 1984, the Malaysian director general of wildlife and national parks expressed interest in collaborating with the Smithsonian Institution in the area of training and research. In response, the first wildlife conservation and management training course was presented in 1986 at Bukit Rengit (Krau Game Reserve), and three courses were given the following year to 57 participants, most from Association of South East Asian Nations countries.

The Malaysian minister for science, technology, and environment proposed formalization of the program, and as a result the International Center for Biological Conservation became a cooperative enterprise among the Department of Wildlife and National Parks, the National University in Kuala Lumpur, and the Smithsonian Institution. Its broad goal—to promote the conservation of biological diversity—is to be implemented through a program of advanced study leading to graduate degrees. According to the plans, the Malaysian protected area system will provide sites for long-term studies of ecology, the National University will establish advanced degree programs, and the Smithsonian's National Zoological Park will consult with the university on curriculum development and priority areas for conservation research and education.

To support the center, the Wildlife Department recently expanded its training and dormitory facilities at the Krau Game Reserve in Lancang. A team of six course instructors from the Wildlife Department has assumed a large share of responsibility for course instruction. The department recently developed its own curriculum for a national biodiversity inventory, and, by training state wildlife employees in vertebrate inventories and specimen preparation, the wildlife department is systematically surveying forest fragments scheduled for deforestation and cultivation.

Conclusions

The Smithsonian training courses and their derivatives and the international and regional centers are enhancing the technical and scientific capacity of developing countries to deal with the biodiversity crisis. We anticipate the growth of these programs as more countries develop national centers for biodiversity in response to the Rio de Janeiro Biodiversity Convention, and we hope to see similar ventures on the part of other scientific and educational institutions.

International conservation training is a stimulating challenge with rewards for both teachers and students. From the training enterprise grows a mutual appreciation of cultural differences between the developed and the developing world, as well as of other factors impinging on environmental conservation. These mutual educational benefits are at the core of work inteneded to overcome the global environmental problems of the next millennium.

References cited

Adams, J. S., and T. O. McShane. 1992. *The Myth of Wild Africa: Conservation without Illusion.* W.W. Norton, New York.

Bierregaard, R. O. Jr., T. E. Lovejoy, V. Kapos, A. A. dos Santos, and R. W. Hutchings. 1992. The biological dynamics of tropical rainforest fragments. *BioScience* 42: 859–866.

Boggin, J., V. Funk, C. Kelloff, M. Hoff, and C. Feulliet. 1992. *Preliminary Checklist of the Vascular Plants and Bryophytes of the Guianas (Guyana, Surinam, French Guiana).* Center for the Study of Biological Diversity, Georgetown, Guyana.

Committee on Nonhuman Primates (CNP). 1981. *Techniques for the Study of Primate Population Ecology.* National Academy Press, Washington, DC.

Dallmeier, F., R. B. Foster, C. B. Romano, R. Rice, and M. Kabel. 1991. *User's Guide to the Beni Biosphere Reserve Biodiversity Plots 01, 02, 03, and 04, Bolivia.* The Smithsonian Institution/Man and the Biosphere Biological Diversity Programs and Beni Biological Station, Academia de Ciencias, La Paz, Bolivia.

Dallmeier, F., M. Kabel, and R. Rice. 1992. Methods for long-term biodiversity inventory plots in protected tropical forest. Pages 11–72 in F. Dallmeier, ed. *Long Term Monitoring of Biological Diversity in Tropical Forest Areas: Methods for Establishment and Inventory of Permanent Plots.* MAB Digest, UNESCO, Paris, France.

Harrison, R. 1972. Understanding your organization's character. *Harvard Business Review* May-June: 119–128.

Heyer, W. R., R. W. McDiarmid, M. Donnelly, L.-A. Hayek, and M. Foster. 1993. *Measuring and Monitoring Biological Diversity: Standard Methods for Amphibians.* Smithsonian Institution Press, Washington, DC.

International Union for the Conservation of Nature, UN Environment Programme, and World Wildlife Federation. 1980. World Conservation Strategy: living resource conservation for sustainable development. IUCN, Morges, Switzerland.

Lovejoy, T. E., and R. O. Bierregaard Jr. 1990. Central Amazonian forests and the Minimum Critical Size of Ecosystems Project. Pages 60–74 in A. Gentry, ed. *Four Neotropical Rainforests.* Yale University Press, New Haven, CT.

Lovejoy, T. E., R. O. Bierregaard Jr., A. B. Rylands, J. R. Malcolm, C. E. Quintela, L.

H. Harper, K. S. Brown Jr., A. H. Powell, G. V. N. Powell, H. O. R. Schubart, and M. Hays. 1986. Edge and other effects of isolation on Amazonian forest fragments. Pages 257–285 in M. Soule, ed. *Conservation Biology.* Sinauer Assoc., Sunderland, MA.

Lovejoy, T. E., and H. O. R. Schubart. 1989. Biological Dynamics of Forest Fragments Project (Minimum Critical Size of Ecosystems Project), a binational project of the World Wildlife Fund, the Smithsonian Institution, and the Instituto de Pesquisas da Amazonia: tenth annual report (November 1, 1988–October 31, 1989).

Miquelle, D. 1992. Wildlife training program surveys participants. *Conservation and Research Center Newsletter* 5: 10–12.

Robinson, M. H. 1989. The zoo that is not: education for conservation. *Conserv. Biol.* 3: 213–215.

_____. 1992. Global change, the future of biodiversity and the future of zoos. *Biotropica* 24: 345–352.

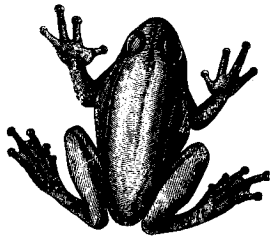
Rudran, R., C. Wemmer, and M. Singh. 1990. Teaching applied ecology to nationals of developing countries. Pages 125–140 in E. R. Goodland, ed. *Race to Save the Tropics: Ecology and Economics for a Sustainable Future.* Island Press, Washington, DC.

Ulloa, R. 1990. An assessment and evaluation of the Smithsonian Institution biological diversity program international workshops training series: a case study. Master's dissertation, School of Natural Resources, Ohio State University, Columbus.

US Interagency Task Force. 1985. US strategy on the conservation of biological diversity: report to Congress. Government Printing Office, Washington, DC.

Wemmer, C., C. Pickett, and J. A. Teare. 1990. Training zoo biology in tropical countries: a report on a method and progress. *Zoo Biol.* 9: 461–470.

Chris Wemmer is the associate director for conservation and Rasanayagam Rudran is the conservation training officer at the National Zoological Park, Conservation and Research Center, Front Royal, VA 22630. Francisco Dallmeier is the director of the Man and the Biosphere Biological Diversity Program, Smithsonian Institution, International Center (SI/MAB), Washington, DC 20560. Don E. Wilson is the director of the Biological Diversity Program, Smithsonian Institution, International Center (SI/MAB), Washington, DC 20560.



BioScience is the monthly magazine for biologists in all fields. It includes articles on research, policy, techniques, and education; news features on developments in biology; book reviews; announcements; meetings calendar; and professional opportunities. Published by the American Institute of Biological Sciences, 730 11th Street, NW, Washington, DC 20001-4521; 202/628-1500. 1993 membership dues, including *BioScience* subscription: Individual $49.50/year; Student $27.50/year. 1993 Institutional subscription rates: $110.50/year (domestic), $138.00/year (foreign).