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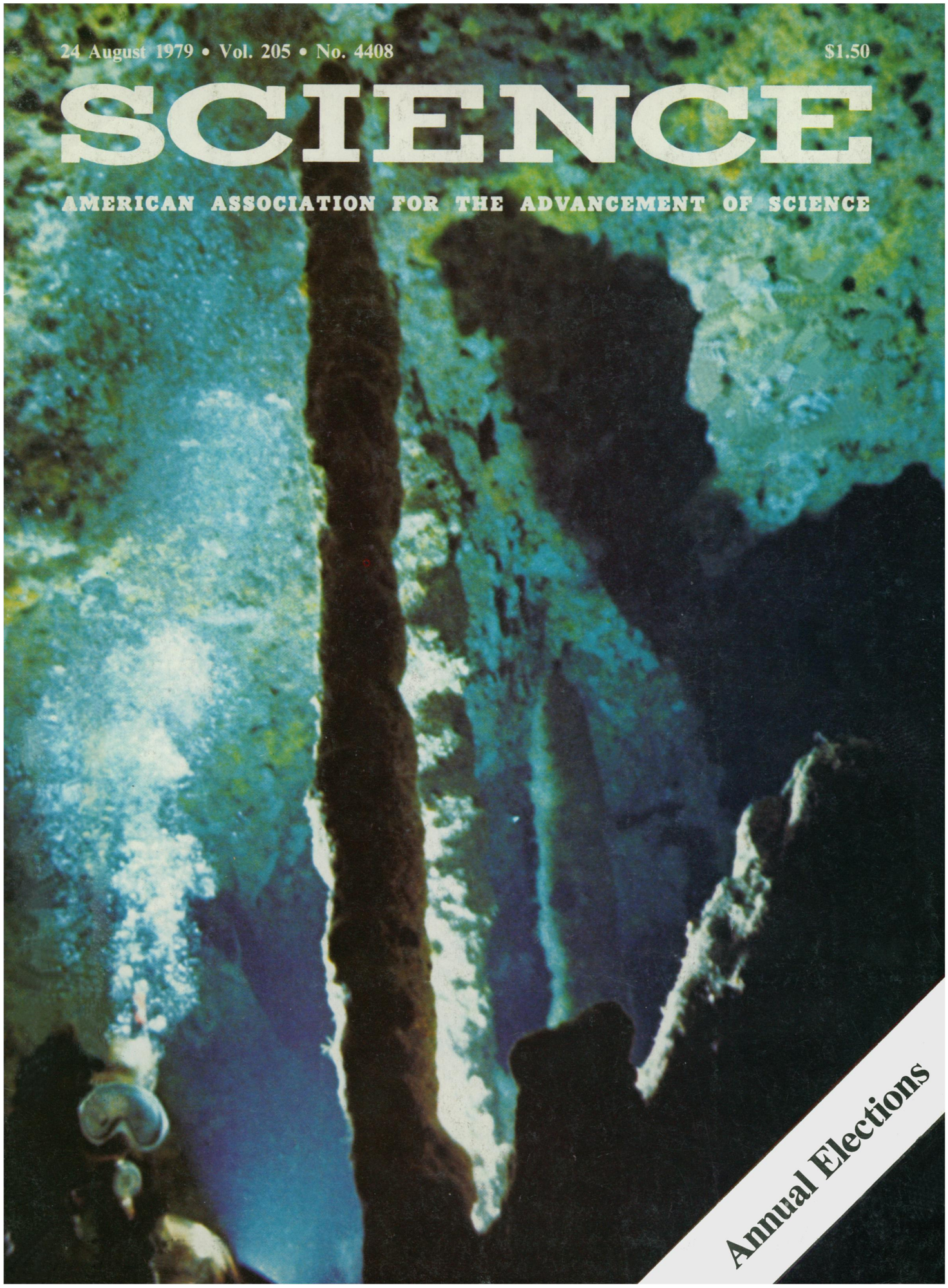

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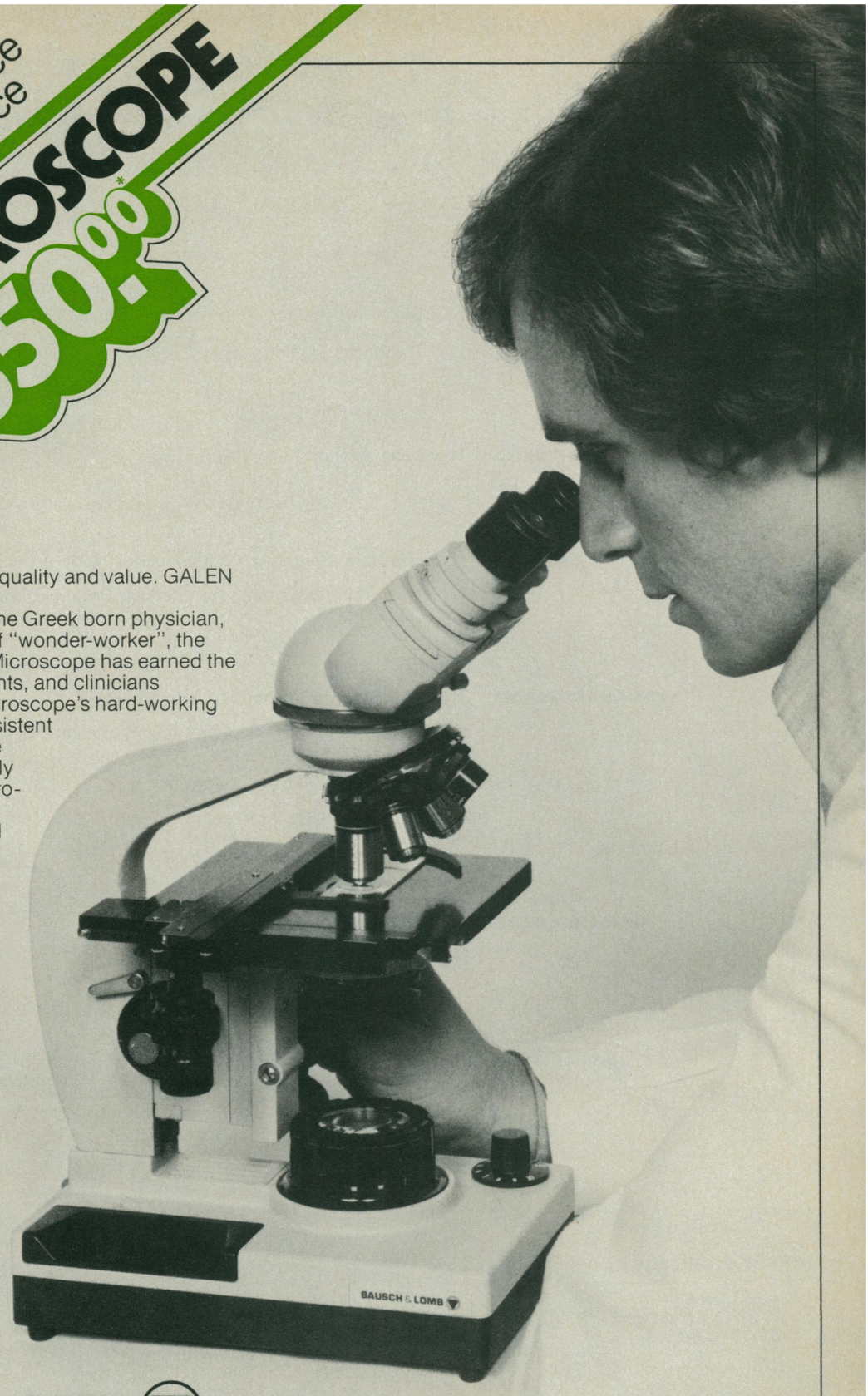


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**COVER**

Stalagmite found 45 meters below sea level in a "blue hole," a drowned karstic cave near Andros Island in the Bahamas. Uranium series dating of this stalagmite provides an estimate of the time of sea-level change at the end of the Illinoian glacial stage. See page 806. [George J. Benjamin, Benjamin Film Laboratories Ltd., Toronto, Canada]

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30 to 40 percent of the output of the extramural contract program of NCI's Division of Cancer Cause and Prevention for 5 percent or less of their budget.

Our personal contributions to the area began in the late 1940's. Certainly Smith must be familiar with the review article in *Cancer Research (4)* urging that carcinogenicity testing be made part of chronic toxicity testing. One of us (P.S.) can justifiably claim a major role in urging, via the National Advisory Cancer Council and the National Cancer Advisory Board (NCAB), that more funds be alloted to investigate environmental carcinogenesis. We also had a major role in training many of those now engaged in this field, including Saffiotti, Lijinsky, Tomatis, Della Porta, Mirvish, Toth, Montesano, Cabral, Keefer, Rappaport, and Magee.

The real reasons for the blunders Smith assigns to NCI are not likely to be discovered through audits by GAO, HEW, and so forth. The problems are a reflection of the present state of the sciences that underwrite this program. Individual bioassays pose separate scientific problems and, more crucial, there is a need for new approaches and a careful evaluation of procedures.

The developments during the present decade have been much more complex than they appear from Smith's oversimplified article. Debates have been held at the NCAB; discussions have taken place during congressional hearings; new legislation has been enacted. Great confusion has been engendered about the role of NCI and that of the regulatory agencies. Implications of responsibility have been made where none have existed, and roles have been entirely misunderstood.

If *Science* is to represent the scientific community, any discussion of carcinogen testing should surely include the scientific merits of such a procedure. Nowhere does Smith even ask whether routine testing should be done at all. Finally, a distinction should be made between an academic cancer institute such as Eppley and a commercial testing facility.


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## Risks and Public Policy

The Three Mile Island nuclear reactor accident has dramatized not only the role of nuclear power but that of other complex, science-based technologies in our society. It is important, therefore, to draw the maximum lesson from the accident, and the President, Congress, the Nuclear Regulatory Commission (NRC), and the nuclear industry have announced investigations in order to do just that. As a result, a lowering of the risk to the public from nuclear power reactors is to be expected.

Looking beyond nuclear power to the general issue of risks/benefits to the public from applying complex technologies, there appears to be one conclusion from Three Mile Island that can be made already: Accurate multidisciplinary assessments of any highly complex technology cannot be guaranteed until after a period of trial and error. The unavoidable risks during that period should therefore be countered with extra, defense-in-depth safety measures.

In the case of the Three Mile Island accident, the most noteworthy fact, in my opinion, is not that material and human malfunctioning apparently were encountered along with bureaucratic and organizational inefficiencies (although the NRC should be commended for its choice of procedure of cooling down the reactor), but that the reactor got into a potentially dangerous failure mode that had not been foreseen. This failure mode was (i) unanticipated; (ii) metastable; and (iii) potentially dangerous to the public.

To an impartial observer, before the accident the NRC would appear to have done all that it could reasonably be expected to have done to learn the potential failure modes of operating light water nuclear reactors. It had available the $1-million-plus Rasmussen study, an independent evaluation of it by a special group of the American Physical Society, several evaluations by special interest groups, and a recent additional review of the Rasmussen study that was sponsored by the NRC itself. In none of these studies was the NRC led to believe that a large bubble of hydrogen would form inside a reactor vessel.

The general public may well wonder if this is the best it can expect from the scientific community. The answer, of course, is, No. Scientists can pay more attention to the discipline of risk assessment; they can recommend designs incorporating more monitoring instrumentation and defense-in-depth safety measures designed to avoid a broader spectrum of failure modes. Also, a wider

group of scientists, both as regards discipline and professional affiliation, can become involved in risk assessment, which can then be isolated from some of the pressures of special interests.

Whereas the occurrence of a Three Mile Island syndrome in the highly developed field of nuclear technology may appear surprising to some, analogous phenomena are almost taken for granted by economists and political scientists. In their struggle, they appear to be more concerned with the theory and practice of decision-making under conditions of uncertainty than with actually trying to reduce the uncertainty that influences their decisions. At a given time, it may not be possible to remove *all* existing uncertainty, but a minimization of it can always be attempted and a corresponding technological solution outlined. The accuracy and objectivity with which the risk assessment of a complex technology can be carried out ought to be emphasized in the political process of its evaluation.

SIGURD O. NIELSEN*
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*Guest scholar

**Dysmenorrhea Treatment**

The Research News article "Dysmenorrhea: basic research leads to a rational therapy" (13 July, p. 175) seems to describe precisely the type of approach to health problems that we all seek but seldom find. The enthusiasm for such a rare occurrence may have, however, led to an overly optimistic and potentially dangerous conclusion. If indeed dysmenorrhea is caused by overproduction of prostaglandins E and $F_{2\alpha}$, perhaps, before putting 30 to 50 percent of women of childbearing age on the rational therapy to depress their synthesis, we should consider two points. The most important is that it is possible that such a widespread "biochemical abnormality" may have a functional role that we do not yet understand. A related point is that the article appears to advocate additional drug therapy for a very large segment of the population. Experience should have taught us by now that simple solutions, especially when applied on a large scale, are likely to lead to unexpected and unpleasant consequences even when the solution is based on rational and elegant research.

HAROLD M. SWARTZ
*Department of Radiology,*
*Medical College of Wisconsin,*
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24 August 1979, Volume 205, Number 4408 **SCIENCE**



# Women in Science

Ten percent of the active American women physicists with a Ph.D. degree received their degrees in the 1977–78 academic year. These 66 new women doctorates amounted to 6.8 percent of the total Ph.D.'s awarded last year. This representation of women among physics Ph.D.'s has increased steadily from only 2.6 percent in 1972. But almost half of this increase is due to the total number of physics doctorates decreasing from 1438 to 971.

But the problems of women physicists are not fully reflected in these figures. Compared to their male counterparts, women physicists experience five times as much unemployment, are paid less, and work in positions of lesser rank. All this adds up to a waste of talent and a demonstrable inequality of opportunity and incentive for young women interested in physics.

The American Physical Society's Committee on the Status of Women in Physics has studied this situation since 1971, and believes that two major obstacles to scientific careers for women must be overcome. Early influences discourage women from acquiring the appropriate academic foundations, and women once trained must have equal opportunities and rewards to pursue their careers. Four suggestions for national action are offered:

1) Initiate programs no later than in junior high school to attract girls to scientific and engineering careers while their mathematical performance is still fully competitive with boys.

2) Modify criteria for fellowships and other scientific awards so that they do not put women with career delays or interruptions at an unfair disadvantage (such as those stipulating limits of age or years since highest degree).

3) When collecting the needed reports and data on women in science and engineering, keep the paperwork and administrative details to a minimum.

4) Provide incentives (such as the equal opportunity awards suggested by Senator Kennedy) for people most responsible for fostering the careers of women scientists and engineers.

Senator Kennedy has introduced a bill (S.568) called the Women in Science and Technology Equal Opportunity Act. This bill, providing a welcome indication of congressional awareness of the issue, would require implementation by the National Science Foundation (NSF). Through programs initiated by the NSF, science and mathematics courses in elementary and secondary schools would be strengthened, with emphasis being placed on gaining the interest of female students; and supplementary training for teachers and workshops for parents would be provided. Higher education programs would prepare women for careers in science, and a continuing education program would assist women scientists in the work force and in periods of interrupted careers.

Under Title 3, the bill would provide for a variety of public information programs, including a clearinghouse for information on women in science and programs for museums, communities, and media aimed at promoting public awareness of scientific careers for women. It would also establish prizes for constructive activity toward advancement of women in science.

The last title, "Equal Employment Opportunity," contains nondiscrimination clauses that would have considerable impact on federally supported laboratories. Among the penalties for noncompliance is one sure to be controversial: an arbitrary reduction in permitted overhead reimbursement on federal projects for institutions having the lowest percentages of women participating in scientific activity.

The NSF recently announced funding for 28 Science Career Workshops aimed at increasing the participation of women in science. These workshops should help to define problems and alternative solutions going beyond those in S.568. But hearings should be held on this proposal to bring closer the day when a consensus is reached on how this country will ensure the full participation of its talented women in scientific and engineering careers.

—LEWIS M. BRANSCOMB, *President, American Physical Society, 335 East 45 Street, New York 10017*