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European Women in Science

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European universities have been informally and formally closed to women from their founding in the twelfth century until the late nineteenth century. A few, exceptional women scientists received Ph.D.s and taught in these institutions before 1900: Laura Bassi served as lecturer in physics at the University of Bologna from 1732 to 1778 and held the chair in experimental physics at the prestigious Istituto delle Scienze from 1776 until her death in 1778 (Findlen 1993; Ceranski 1996). Anna Morandi Manzolini replaced her husband as lecturer in anatomy at the University of Bologna in 1755 (Messbarger 2001). Dorothea von Schlözer, daughter of the renowned Göttingen historian, received a doctoral degree for her work in mineralogy in 1787 (Schiebinger 1989, 257–60). These intermittent positions awarded to women were unique to Italy and Germany; none were granted women in England or France. Nowhere in Europe did women gain regular access to universities until the late nineteenth century.

The twentieth century witnessed a historic turnaround for women and their gradual incursion into the halls of science. Early in the century women were admitted to university study nearly everywhere in Europe. By mid-century they were receiving Ph.D.s, and by the end of the century women had taken their place as professors. Though numbers differed across Europe, countable percentages existed everywhere. Statistics collected between 1996 and 1998 show the Netherlands and Germany tied with the lowest percentage of women full professors (5.9 per cent each); Austria, Belgium, and Ireland all ranged between 6 and 6.8 per cent; the United Kingdom with 8.5 per cent, France at 13.8 per cent, and Portugal and Finland (17 and 18.4 per cent female full professors respectively) had the highest percentages (European Commission 2000, 10).[1]

In 1997, the European Union (EU) Treaty of Amsterdam (Articles 2 and 3) strengthened EU commitment to "equal opportunities" and "equal treatment" for

[1] Academic systems differ greatly from country to country. The EU is currently collecting statistics that offer consistent comparisons across countries. In Germany, for example, a full professor (C4) is also the director of a division, making this a difficult rank to achieve. These statistics are for all fields (natural and medical sciences, humanities, and social sciences). For a breakdown of these statistics, see Costas in this issue and Laafia and Larsson 2001.

men and women; member states[2] are encouraged through EU policy and funding to create equal opportunities for men and women in all areas of public life, including science. Since the European Union established its Women and Science Unit in 1998, European member states have been jockeying for the best numbers in the women-in-science competition. The three articles here – discussing scientific traditions in the Netherlands, France, and Germany – will examine the historical background of the exclusion of women in those countries, the transition to inclusion, and some preliminary results of new EU policies designed to incorporate gender analysis in all areas of academic research. The authors of these articles are well-recognized scholars in their fields and centrally involved in orchestrating policies and programs to open the sciences to women at either the EU or national levels.

Europe stands at a historic crossroads in regard to gender and science: The French, who in the past have assumed that Enlightenment notions of *egalité* and *fraternité* would afford women equal opportunities, are now extending the politics of *parité* to the halls of science. In 2001, the French Ministry for Research launched its *Mission Parité en Sciences et Technologies* to advance research in the area of gender in science. The Germans have also set up governmental offices in Bonn focused on expanding equal opportunity, equal pay, increased female leadership, and "gender mainstreaming"[3] in all "concepts, processes, and measures" in science (Ebeling 2001). In addition, a law has been put forward to the German parliament that would set (positive) quotas for women in senior research positions (20 per cent by year 2005). This controversial policy, if enacted, would amount to a social revolution in a country where women are still often expected to choose between profession and family, and where in 2000 women held only 6.5 per cent of top-level professorships (C4) and only 2.6 per cent of leading positions in top German research institutes, such as the Max-Planck-Gesellschaft (see Costas in this issue).

In detailing how the study of science was opened to women over the course of the late nineteenth and early twentieth centuries, the following three articles document the formal legal and informal cultural barriers to women's participation in academic life. Since Robert Merton, science theorists have described the normative structure of modern science in various ways: as, for example, characterized by universalism, communism, disinterestedness, and a type of organized skepticism that underwrites the international, impersonal, even anonymous character of science, and demands that careers be open to talent (Merton 1973, 267–78). Scientific institutions, cultures,

[2] European Union member states – Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, and the United Kingdom – all have passed legislation prescribing equal treatment for men and women. Many EU associated states (Czech Republic, Hungary, Iceland, Israel, Latvia, Lithuania, Malta, Norway, Poland, Romania, Slovakia, and Slovenia) have also passed such legislation. Bulgaria, Cyprus, and Estonia have not.

[3] Mainstreaming is the standard EU approach to efforts to create equality. Mainstreaming is defined by T. Rees as the systematic integration of equal opportunities for women and men into science organizations, their cultures, and into all programs, policies and practices: "into ways of seeing and doing" (Rees 1998; see also European Commission 2000, 65–79).

and research, however, have not been "disinterested" in respect to gender (for a summary of this literature, see Schiebinger 1999). Science practices that for centuries have held women at arm's length stand in stark contrast to efforts these days to legislate women into science. The articles presented here discuss current efforts in Europe to right past wrongs though elaborate national legislation and changes in university policies.

Efforts to legislate women into science raise many issues; in the remainder of this introduction I will discuss two. (1) It will be obvious that many European reforms are modeled on United States programs that for the past twenty years have sought in various ways to open equal opportunities to women in science. Is this wise? Do such programs that emerged from American historical traditions transfer easily to a European context? What limits are built into the American strategies for achieving equality? Can the EU, by taking the best from the United States, outperform it – in gender equality and in science? (2) Gender equality in Europe is currently being encouraged from the top down.[4] What will be the consequences of all this for science? How, in a climate of goodwill, can governments best move along the process of opening science to women?

Legislating Women into Science

The democratic process pushing forward current efforts to mainstream gender into science congealed with the passage of Articles 2 and 3 of the 1997 European Union Treaty of Amsterdam. The wording and spirit of these articles are interesting. The EU resolved to eliminate inequality *and* actively to promote equality between men and women; policy makers resolved to embrace "positive discrimination," or affirmative action, in efforts to redress past negative discrimination. To work toward gender equality in the sciences, the European Union founded the Women and Science Unit in 1998 (Dewandre 2002). It also established the "Helsinki Group" (it met in Finland) of representatives from member states to coordinate policy on these issues across Europe (Rees 2002). It has also made gender analysis an integral part of its Sixth Framework Programme that sets EU research policy for the period 2002–2006 (European Union 2002). Current EU efforts focus on women in public research universities and institutes; work on gender issues in industry is only just beginning.

One European Union strategy has been to study the United States, where university and government programs aimed at moving women into science and engineering have been underway since the early 1980s. The United States has a (relatively) respectable number of women in senior academic positions (14 per cent) and a comfortable climate for women in many universities and government agencies.

[4] I do not mean to underestimate the work by women scientists and others in Europe who strive daily for reform. What I am interested in here is the role of governments in the process of increasing equal opportunities for women.

The Chief Scientist at NASA and the Director of the National Institutes of Health (NIH) have both been women, and currently women serve as presidents at six major colleges and universities (Duke University, University of Michigan, University of Illinois at Urbana-Champaign, Rensselaer Polytechnic Institute in New York, Bennett College in North Carolina, and the University of Miami) and three Ivy-League universities (Princeton University, which admitted women only in 1969, Brown University, and the University of Pennsylvania). Three of these women are African-Americans.[5]

Several models for equality operate in the U.S. The narrowest models inform policy within the National Science Foundation (NSF) and the recent Congressional Commission on the Advancement of Women and Minorities in Science, Engineering and Technology Development. Programs at the NSF are limited to promoting women's participation in science, along with that of minorities and persons with disabilities; the point has been to increase the supply of qualified women through fair and equitable education (at all levels) and career development. Since the 1980s, the NSF has had a number of programs for women, including the Program for Women and Girls, the Visiting Professorships for Women, Faculty Awards for Women, Research Planning Grants for Women, Career Advancement for Women, the Professional Opportunities for Women in Research and Education (POWRE) and now ADVANCE programs (NSF 2001).

The EU has embraced this type of equal opportunity thinking, and its Research Directorates (RDs) have taken the lead over the U.S. by setting positive quotas (the "target" is 40 per cent women) for all internal committees that implement and manage research. While the EU RDs achieved only 20 to 30 per cent women in most committees in 2000, this was up from 10 per cent just two years earlier, and some committees (such as the External Advisory Groups for the Human Potential, and the Environment and Sustainable Development research programs) met the 40 per cent goal (Laurila and Young 2002).

The EU has taken an important second step: providing funds to cultivate research equity. (Although EU funding currently comprises only about 5 per cent of all research and development in Europe, that is expected to grow.) Bernadine Healy, formerly head of the NIH in the U.S., put it simply: "let's face it, the way to get scientists to move into a certain area is to fund that area" (Gura 1995, 773). And, indeed, this has proven successful in the U.S. In 1994, for example, when the NSF threatened to cut funding to the prestigious U.S. Aspen Center for Physics because the Center was not doing enough to support women, the Aspen Center sponsored a week-long meeting devoted to gender issues and subsequently adopted many of the participating scholars' recommendations, including providing on-site daycare, coordinating couples' visits, increasing the number of women on the executive council, and reducing what several of the women physicists at the Center identified

[5] That is not of course to say that women enjoy full equality in the U.S. Women still earn only about 13 per cent of all Ph.D.s in physics, for example, and this has not changed in the last decade.

as its "machismo" culture. The EU is currently offering matching funds up to 1 million Euros to member states for women and science initiatives (see the Hermann and Cyrot-Lackmann article in this issue).

The EU has also borrowed from U.S. affirmative action programs, requiring that its contractors promote equal opportunities for women. Concrete programs range from reforming science education for girls at the primary and secondary school levels, to providing more university scholarships for female students, to requiring that university committees – especially those that oversee recruitment and promotion – include roughly equal numbers of males and females. The EU recommends a minimum of 40 per cent participation by women on journal boards, serving as referees, on committees determining funding, and (most importantly) on science policy committees. The EU intends to act as a catalyst and equity broker for Member States, though it should also be recognized that some countries are ahead of EU policy. Finland, for example, already in 1995 required a minimum of 40 per cent of both sexes on all national committees, including its National Research Councils. And Italy since 1997 has required a minimum of 30 per cent of each sex on committees for hiring and promotion at universities and research councils (European Commission 2000, 83).

European Union recommendations and programs are best summarized in the celebrated European Technology Assessment Network (ETAN) report (European Commission 2000), which discusses the problems European women face in science and offers policy solutions. Many of these solutions will be familiar to American audiences: Europe seeks to promote fairness in funding, salaries (where this does not already exist), peer review, and hiring practices; it seeks to provide positive female role models and images of science, along with special programs for women reentering scientific careers from some other life-track.

Of course, there are enormous problems in mandating equal participation when there are relatively few women to choose from. On the one hand, recruitment goals have to take into account the proportion of qualified women in the candidate pool. Where women make up, say, 20 per cent of those earning Ph.D.s in a particular field, it is unreasonable to ask that more than 20 per cent of the scientists be women at the entry level of the academic hierarchy. On the other hand, the demand now to include women in the process of making decisions places a burden on those relatively few women who "make it" into the higher ranks and who tend to be in high demand (for example, for committee assignments). Successful women scientists often juggle two sets of professional demands – the demands of running first-rate research programs and the demands of advocating for equality.

Current EU efforts seek to retain a greater portion of the percentage of ready female Ph.D.s for the professorial ranks. Women, in fact, do not progress up through the ranks at the same ratios as their male counterparts. This problem is known as the "leaky pipeline." The pipeline model – the idea that increasing the supply of girls interested in science will eventually result in greater numbers of women professionals

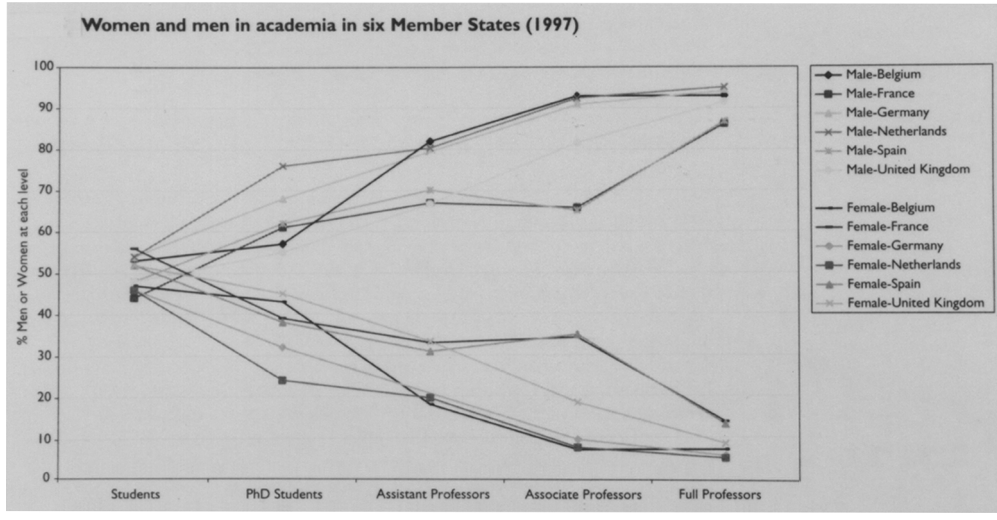

Fig. 1. The ETAN Report's "scissors" diagram shows that the lack of women at the top levels of scientific research cannot be explained by a lack of women in the "pipeline" (European Commission 2000, 13). Courtesy of the Women and Science Unit, DG Research, European Commission, Brussels.

– has been found to be faulty. Women drop out of scientific careers at a much higher rate than their male counterparts at every level, especially at the post-graduate and professorial levels. This is quantified in the now-infamous "scissors" diagram that reveals that a higher proportion of women than men receiving an undergraduate degree does not ensure that an equal number of women will reach the higher ranks (fig. 1).

Mainstreaming Gender Analysis into Science

In the United States, different agencies have different track records in promoting gender equality. NSF programs pale in comparison to those at the NIH, for example. In contrast to the NSF, the NIH Office of Research on Women's Health (ORWH), founded in 1990, provides a broader and deeper model for promoting equality for men and women in the sciences. The ORWH was founded with two interrelated missions: to increase the number of women in the medical profession and to reconceptualize medical research to include women. Thus the NIH took the crucial step of joining increased opportunities for women in medicine to mainstreaming gender analysis in medical research. This approach has not only increased the number of women in the medical sciences, but has also brought about a revolution in biomedical research (ORWH 1999). Only a decade ago, females (human and

non-human) were rarely used in basic biomedical research and drug testing; today the inclusion of a representative mix of females in clinical trials is secured by U.S. federal law. The NIH has also launched the Women's Health Initiative, a fourteen-year $625 million study of historically-neglected aspects of women's health – such as heart disease, breast cancer, and osteoporosis. This is the largest single project ever funded by the NIH. In addition, between 1990 and 1994, the U.S. Congress enacted not fewer than twenty-five pieces of legislation to improve the health of American women. This revolution in biomedical research in the U.S. is resulting in better medical care for women of all ages and ethnic/racial backgrounds (Mastroianni et al. 1994; Ruzek et al. 1997).

The EU Commission on Women in Science has moved beyond the U.S. to generalize this approach – tying women's career advancement to correcting gender bias in the substantive outcomes of research – to all areas of scientific research, not just biomedical. In the words of the 1999 EU resolution: the point is to mainstream research "by, for, and about" women into all fields of science (EU Commission 1999). Though this phrase grates on some American ears as a throwback to the 1970s, it captures the sense that change must occur in several different interlocking domains: research "by" women (issues of equity and inclusion), research "for" women (considering women's needs in setting scientific priorities) and research "about" women (mainstreaming gender analysis into basic research). The EU requires researchers to treat the gender dimensions in research questions and research methodologies.

Here is where the EU has the potential to overtake the U.S. in getting women into science and gender into scientific research. The EU is implementing a system that evaluates the gender content in all government-sponsored research – something that does occur within the U.S. NSF. Gender experts in the EU are mandated to evaluate the extent to which gender considerations have been "mainstreamed," or integrated, at all levels of research from personnel considerations, to science policy, calls for proposals, contracts, and finally into the research itself, where relevant. The EU has implemented "Gender Impact Assessment" as part of its basic research programs (Laurila and Young 2002). The U.S. has seen dramatic innovations in the medical science, social sciences, and humanities using this mainstreaming approach; however, the natural sciences are lagging behind for lack of government policy in this area.

One obstacle to mainstreaming gender analysis into science in Europe at the moment is that there are few gender experts. While most people agree that a student needs to learn biology or physics in order to excel in those fields, many believe that one can just "pick up an understanding of gender along the way." Understanding gender, however, requires research, development, and training, as in any other field of intellectual endeavor. The NIH programs in the U.S. work, for example, because a solid body of cutting-edge gender research is available from a number of leading U.S. universities. Not all European universities, however, have embraced gender studies over the past twenty years (for the problems associated with European

universities that have invested in women's studies, see Bosch in this issue).[6] Countries, such as France, that have invested relatively little in gender research in the past, are now earmarking funds to import foreign experts to bring researchers up to speed in this area.

Understanding how gender works in science is crucial for both mobilizing human resources and for bringing new perspectives, priorities, and creative ferment to science. Intelligent gender analysis has added new critical dimensions, devised new correctives, opened new questions and perspectives, ferreted out old stereotypes, and enhanced creativity in a number of sciences (Schiebinger 1999; Creager et al. 2001). Gender analysis is something science students need to be trained in. A positive development in the U.S. that might be replicable in Europe is the growing number of scholars grounded in gender studies of science working inside the sciences. These scholars can embed gender analysis into basic research and also train the next generation in these methods (Schiebinger 2003).

The three articles that follow document the political and cultural structures that have impinged upon women's advances in the sciences across the nineteenth and twentieth centuries. They also outline the recent advances in opening science to gender research.

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References

Ceranski, B. 1996. *"Und Sie Fürchtet sich vor Niemandem": Die Physikerin Laura Bassi, 1711–1778*. Frankfurt: Campus Verlag.

Creager, A., E. Lunbeck, and L. Schiebinger, eds. 2001. *Feminism in Twentieth-Century Science, Technology, and Medicine*. Chicago: University of Chicago Press.

Cyrot-Lackmann, Françoise. 2002. *Les Femmes dans la recherche française: Livre blanc*. Paris: Ministère de la Recherche.

Dewandre, N. 2002. "European Strategies for Promoting Women in Science." *Science* 295:278–9.

Ebeling, H. 2001. *Frauen in Bildung and Forschung: Gender Mainstreaming*. Bonn: Bundesministerium für Bildung und Forschung.

[6] In the case of the Netherlands, women's studies became relatively highly developed but ghettoized (see Bosch below). In the U.S. professors of women's studies commonly hold a joint appointment in a traditional discipline (a professorial appointment is typically 51 per cent in the traditional discipline and 49 per cent in women's studies). This arrangement has done much to mainstream the results of gender research into the traditional disciplines.

European Commission. Research Directorate-General. 2000. *Science Policies in the European Union. Promoting Excellence Through Mainstreaming Gender Equality.* A Report from the ETAN Expert Working Group on Women and Science. Luxembourg: Office for Official Publications of the European Communities. This publication is available on line: ftp://ftp.cordis.lu/pub/improving/docs/g_wo_etan_en_200101.pdf.

European Union. 2002. Decision No. 2002: EC of the European Parliament and of the Council, 27 June 2002 Concerning the Sixth Framework Programme of the European Community for Research, Technological Development and Demonstration Activities, Contributing to the Creation of the European Research Area and to Innovation (2002–2006) (Brussels: European Union).

EU Communication from the Commission. 17 February 1999. "Women and Science: Mobilising Women to Enrich European Research." Brussels: European Commission.

Findlen, P. 1993. "Science as a Career in Enlightenment Italy: The Strategies of Laura Bassi." *Isis* 84:441–69.

Gura, T. 1995. "Estrogen: Key Player in Heart Disease Among Women." *Science* 269:771–3.

Laafia, I. and A. Larsson. 2001. "Women in Public Research and Higher Education in Europe." *Statistics in Focus: Science and Technology.* Brussels: European Communities.

Klinge, I. and M. Bosch. 2001. *Gender in Research: Quality of Life and Management of Living Resources*. Brussels: European Commission.

Laurila, P. and K. Young. 2002. *Gender in Research: Gender Impact Assessment of the Specific Programmes of the Fifth Framework Programme.* Brussels: European Commission.

Mastroianni, A., R. Faden, and D. Federman, eds. 1994. *Women and Health Research*, 2 vols. Washington, D.C.: National Academy Press.

Merton, R. 1973. *The Sociology of Science.* Chicago: University of Chicago Press.

Messbarger, R. 2001. "Waxing Poetic: Anna Morandi Manzolini's Anatomical Sculptures." *Configurations* 9:65–97.

National Science Foundation (NSF). 2001. http://www.nsf.gov/home/crssprgm/advance/

Office for Research on Women's Health, *Agenda for Research on Women's Health for the 21st Century.* Bethesda, MD: National Institutes of Health.

Rees, T. 1998. *Mainstreaming Equality in the European Union*. London: Routledge.

Rees, T. 2002. *The Helsinki Group on Women and Science: National Policies on Women and Science in Europe.* Brussels: European Commission.

Ruzek, S., V. Olesen, and A. Clarke, eds. 1997. *Women's Health: Complexities and Differences*. Columbus: Ohio State University Press.

Schiebinger, L. 1989. *The Mind Has No Sex? Women in the Origins of Modern Science.* Cambridge, Mass.: Harvard University Press.

Schiebinger, L. 1999. *Has Feminism Changed Science?* Cambridge, Mass.: Harvard University Press.

Schiebinger, L., ed. 2003. "Feminism in the Sciences." Cluster of articles by M. Conkey on archaeology, P. Gowaty on evolutionary biology, and A. Bug on physics. *Signs: Journal of Women in Culture and Society* 28:Forthcoming.