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EDITORIAL

Women, Science and the X-Chromosome

International Women's Day is celebrated every year on 8th March. The day has been institutionalized by the United Nations, although various dates in March have been previously associated with the struggle for equality of women. The women's rights movement has its origins in the struggle to vote by women in the United States in the latter half of the 19th century, most dramatically highlighted by the 1873 trial of Susan B. Anthony in the United States for illegal voting, Women's Day appears to have firmly rooted beginnings in Europe. March 8 presumably commemorates the famous strike in St. Petersburg organized by Russian women in 1917, a spontaneous uprising for 'bread and peace' in a Russia ravaged by war and ripe for revolution. Today, Women's Day is used to focus attention on the many issues that ensure that women continue to live in an unequal world. This year, I received an invitation to participate in a panel discussion organized by women students at the Indian Institute of Science. At first, I pleaded ignorance of the complexities of the issues involved. But, the student who came to invite me changed my mind with the candidness that sometimes is the defining characteristic of the young. She asked: 'Sir, you have been around this institution for a very long time. Surely, you must know something'. Disarmed by such a compelling argument, I gathered courage to face an audience, which was undoubtedly well prepared to articulate the problems faced by women in science. The discussion touched many familiar but difficult issues: security for working women, discrimination in recruitment, harassment at the workplace, problems of reconciling the demands of families, with the sometimes impossible demands of a research career and the disappearance of highly qualified women scientists from the scientific workforce. Many issues struck a chord. Cannot our institutions be more women-friendly and run high quality child-care centres (creches)? Is there no easy way in which continuity of a research career can be ensured in the years in which young children are to be raised? Is there a 'glass ceiling' which prevents the best of women scientists from rising to the top of their profession? Is there an invisible (or sometimes, barely disguised) men's club, which ensures that the representation of women, in the upper levels of administration and in bodies like academies, is limited? Should there be an 'equal opportunity' movement, which introduces a level of positive discrimination in favour of women? These are familiar issues which have been oft-debated. As is customary, the discussion sparked interest in the issues raised, but I suspect these will remain alive even in future discussions, as the definition of the problems and contours of their solutions still remain on the drawing board.

Gender issues have been discussed widely in India over the last few years. An analysis of women scientists points out rather forcefully that 'women scientists form ... a minor proportion of all working class women'. Using biology as a field for the analysis, Vineeta Bal concludes that 'despite the increase in the number of women scientists in biology, gender-based disadvantages continue to be the order of the day even in academic performance-based competition'. She notes that many women 'lose out in the pursuit of their profession in the early phases. Even for those who cross this hurdle successfully, the profession can make them invisible – not rising far enough to step into leadership roles and not getting recognition. Rumbler strips on the road function as more efficient controllers of speed than a single speed breaker bump, a situation depressingly familiar to women biologists' (*Economic and Political Weekly*, 7 August 2004, pp. 3647–3652). A recent report produced by the Indian National Science Academy (INSA) examines 'Indian women's access to and retention in scientific careers'. The word 'retention' is clearly important. Most M Sc courses and Ph D programs in national institutions have a large proportion of women students. In some areas like biology women can even outnumber men. Inspection of available data on scientists and academic faculty members in diverse institutions, however, reveals that very few women continue to struggle up the scientific ladder. This attrition is undoubtedly a result of the difficulty in pursuing a career that demands an excessive investment of time, in the face of increasing family demands. The INSA report outlines 'steps to reduce stress on women scientists and students and facilitate study and practice of science by women'. Some measures like 'flexible working hours and part-time jobs' and 'age relaxation in recruitment, and 2 mid-career breaks' may increase the number of women scientists, but will do little to enhance the competitiveness of women scientists in an area where peer pressure can be intense. It appears easier to institute welfare measures rather than to level the playing field. The report acknowledges with a tinge of despair: 'Alas – INSA may not be able to change the "patrifocal" (a curious word indeed!) mind-set of society, which has become part of the human psyche'.

Women's issues came to the fore a few weeks before International Women's Day. In a speech delivered on 14

January 2005 at a conference on 'Diversifying the Science and Engineering Workforce', the President of Harvard University, Lawrence Summers made a set of controversial remarks that seemed to imply that innate differences between men and women might account for the lower presence of women in science and engineering. Summers, an economist and a former Treasury Secretary under President Clinton, set the cat among the pigeons with remarks that were soon dubbed as outrageous, leading to a snowballing controversy. *Nature* noted in a cautious editorial that 'what Summers actually said has been harder to discern', since no transcript was available. Following a series of apologies that seemed to satisfy none, the transcript appeared on the Internet. In a long and rambling speech, the offensive sentence suggested 'that in the special case of science and engineering, there are issues of intrinsic aptitude and particularly of the variability of aptitude, and that those considerations are reinforced by what are in fact lesser factors involving socialization and continuing discrimination'. Summers went on to add that he 'would like nothing better than to be proved wrong' suggesting that he was unsure about his 'nature versus nurture' argument. What did Summers imply? The consensus seemed to be that he took the politically incorrect view that women were intrinsically less endowed in practicing the sciences. Summers of course, is no geneticist and his critics quickly went on a rampage. Coincidentally, even as the controversy on the relative abilities of the sexes intensified, the DNA sequence of the human X-chromosome appeared (*Nature*, 2005, **434**, 325).

The X-chromosome, dubbed on *Nature*'s cover as 'the chromosome that unites the sexes' is really the female characteristic; women have two X-chromosomes, one inherited from each parent. In one of biology's magical events, most genes on one of the two X-chromosomes are silenced. Men possess an X and Y pair of chromosomes, with the latter possessing relatively little by way of genetic information, although it does determine 'maleness'. While the X and Y chromosomes evolved from a common ancestor, the latter has 'disintegrated to a shadow of its former self' (Gunter, C., *Nature*, 2005, **434**, 279). To the non-specialist descriptions of the 'male' Y-chromosome convey an impression of a bleak, molecular wasteland, limited to controlling a few defining characteristics of sex. The X-chromosome is more fertile, displaying a genetic richness which surely must yield many new insights in the years to come. Men who harbour critical mutations in the X-chromosome may be more susceptible to X-linked disease; women less so because of their good fortune in inheriting a healthy copy of X from one of the parents. The coin, of course, has another side. There are the inevitable predictions 'that genes on X can benefit males even at the expense of females as the detrimental effects would be masked in females' (*Nature*, 2005, **434**, 279). With 1098 genes identified, the X chromosome presents a formidable challenge to those who wish to make a correlation between genotype and phenotype. The waters are further muddied by interactions between gene products derived from different chromosomes and subtle control of genetic information by differential gene expression. It is unlikely that molecular genetics will provide insights into complex attributes like 'aptitudes for science and engineering'. For answers to the Summers' questions (and these may have been framed in an unwise moment of rhetoric) we must necessarily avoid falling into the trap of blaming nature.

I like to think that what may be loosely termed 'an epidemiological approach' tells us more about the skewed sex ratios as one moves up the totem pole of science and technology. Statistics are available in plenty; worldwide reports, national surveys and even state-wise figures for the presence of women in higher education institutions in India. The data is compelling. Women hold their own successfully, in some fields outdoing men, until the Ph D stage which is reached in the mid-to-late twenties. There is clearly no evidence for any 'intrinsic difference', except where selections may be biased or environments perceived as 'unfriendly'. The decline in numbers is steep at the level of entry into a professional career, with a steady drop-out rate thereafter, till the mid-30s. Women who struggle and stay the course break free of a major barrier imposed by nature and custom, the imperatives of raising a family. There are other hurdles in place, but I suspect that the glass ceiling will crumble, much as the Berlin Wall did many years ago, under the weight of undeniable aspiration.

In optimistically viewing a future that provides a level playing field for women in science (I must here confess that I have invariably been labelled as a pessimist on many other issues), I must draw attention to a book that is compellingly readable, *Nobel Prize Women in Science* by Sharon Bertsch McGrayne (Carol Publishing Group, 1998). The book contains 16 portraits of women, who have made major contributions to science, not all Nobelists. There are three generations; the first includes Marie Curie and Lise Meitner; the second is larger and the names are familiar, Gerty Cori, Barbara McClintock, Dorothy Hodgkin, Chien-Shiung Wu, Rosalind Franklin and Rita Levi-Montalcini among them; the third, small but undoubtedly growing, includes Jocelyn Bell Burnell and Christiane Nüsslein-Volhard. The sketches are inspirational, the hurdles faced clearly stated. Determination and commitment appear to be the key ingredients for success and I suspect this is true for men too.

The book is dedicated to two women whose names were unknown to me, Hilde Proescholdt Mangold and Frieda Robscheit-Robbins. The latter worked for thirty-eight years as the research assistant of George Whipple, who discovered the factor that would 'cure pernicious anemia', work for which he received the Nobel Prize for Medicine in 1934. Whipple was generous in his acknowledgements but Robschiet-Robbins is an unknown figure. But her views on research bear repetition 'You become possessed of a magnificent obsession and determination to learn the truth of your scientific theory if it takes sixteen years or many times sixteen. If you are successful, you really deserve no great credit, for by that time experiment has become the only thing in life you care to do'. This is the sentiment that truly propels science in its forward march, but it is one that can move only the exceptional individual. For the rest of us, the environment must be supporting and encouraging.

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