



ESSAYS ON SCIENCE AND SOCIETY

Sex in an Age of Mechanical Reproduction

In the first half of the 20th century, the onset of menopause was welcomed by many women as a release from continuous pregnancies caused by unprotected and frequently unwanted intercourse. But the arrival of the Pill and other effective contraceptives, together with many more women delaying childbirth until their late 30s or early 40s, raises the concern that menopause may prevent women from becoming mothers at all. Whereas technology's gift to women (and men) during the latter half of the 20th century was contraception, the first 50 years of the new millennium may well be considered the decades of conception. With continuous improvements in assisted reproductive technologies (ART), we are seeing a gradual separation of sex and fertilization, with sex taking place "in bed" and fertilization under the microscope. This separation is shifting the balance of reproductive power into the domain of women.

The first successful ART was the in vitro fertilization (IVF) technique developed by Steptoe and Edwards in the United Kingdom in 1977. They removed a woman's egg and exposed it to millions of her husband's sperm under the microscope. Two days later the fertilized egg was transferred back into the woman's uterus, resulting in the birth, 9 months later, of a healthy baby girl, Louise Joy Brown. Since then, more than 300,000 babies have been born to women who, without IVF technology, would be infertile, a technological feat now taken for granted in the affluent countries of the world.

Although still largely unrecognized, the development of intracytoplasmic sperm injection (ICSI) by van Steirteghem, Devroey and colleagues in Belgium in 1992* was an

even greater technological achievement. These investigators successfully fertilized a human egg by direct injection of a single sperm under the microscope, followed by reinsertion of the egg into the woman's uterus. Given that the fertilization of a woman's egg during normal intercourse requires tens of millions of sperm, and that a man ejaculating even as many as 3 million sperm is still functionally infertile, ICSI is a powerful tool for the treatment of male infertility. More than 10,000 ICSI babies have been born since 1992.

But ICSI may prove to be of even greater benefit to older women who are trying to conceive. This point is perhaps best illustrated by Scene 2 of my "science-in-theater" play, *An Immaculate Misconception* (see page 56 for a review). The protagonists are Dr. Melanie

Laidlaw, a reproductive biologist and (in the play) the inventor of ICSI, and her clinical colleague, Dr. Felix Frankenthaler:

MELANIE: *If your patients knew what I was up to in here, they'd be breaking down my door. Men with low sperm counts who can never become biological fathers in the usual way.*

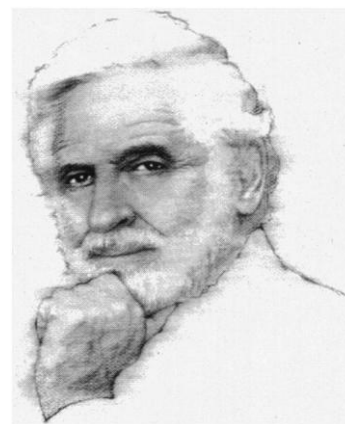
FELIX: *My patients just want to fertilize an egg. They won't care if it's under a microscope or in bed . . . as long as it's their own sperm.*

MELANIE: *You're focusing on male infertility . . . That's your business. But do you realize what this will mean for women?*

FELIX: *Of course! I treat male infertility to get women pregnant.*

MELANIE: *Felix, you haven't changed. You're a first-class doctor . . . but I see further than you. ICSI could become an answer to overcoming the biological clock. And if that works, it will affect many more women than there are infertile men. I'll even become famous.*

FELIX: *Sure . . . you'll be famous . . . world-famous . . . if that first ICSI fertilization is successful . . . and if a normal baby is born. But what's that got to do*



Carl Djerassi

is a professor of chemistry at Stanford University. He synthesized the first steroid oral contraceptive in 1951, for which he received the National Medal of Science. He has written several "science-in-fiction" novels (*Cantor's Dilemma*; *The Bourbaki Gambit*; *Marx, Deceased*; *Menachem's Seed*; *NO*) and has recently embarked on a trilogy of "science-in-theater" plays, the first of which is *An Immaculate Misconception*.

with "the biological clock"?

MELANIE: *Felix, in your IVF practice, it's not uncommon to freeze embryos for months and years before implanting them into a woman. But now take frozen eggs.*

FELIX: *I know all about frozen eggs . . . When you rethaw them, artificial insemination rarely works . . . Something happens to the zona pellucida. And there are other problems . . .*

MELANIE: *But that's my point! Who cares what surrounds the egg? What I'm doing isn't ordinary artificial insemination . . . exposing the egg to lots of sperm and then letting them struggle on their own through the egg's natural barrier. We inject right into the egg . . . Now, think of those women . . . right now, mostly professional ones . . . who postpone childbearing to their late thirties or even early forties. By then, the quality of their eggs . . . their own eggs . . . is not what it was when they were ten years younger. But with ICSI, such women could draw on a bank account of their frozen young eggs and have a much better chance of having a normal pregnancy later on in life. I'm not talking about surrogate eggs—*

FELIX: *Later in life? Past the menopause?*

MELANIE: *You convert men in their fifties into successful donors—*

FELIX: *Then why not women? Are you serious?*

CREDIT: ALAN BURCH
The author is in the Department of Chemistry, Stanford University, Stanford, CA 94305-5080, USA. E-mail: djerassi@stanford.edu

*G. Palermo, H. Joris, P. Devroey, A. C. Van Steirteghem, *Lancet* **340**, 17 (1992).

SCIENCE'S COMPASS

MELANIE: *I see no reason why women shouldn't have that option . . . at least under some circumstances.*

FELIX: *Well—if that works . . . you won't just become famous . . . you'll be notorious. (Pause) So we've got a new method of fertilization. But we've got to demonstrate first that ICSI works with a fresh egg and proven fertile sperm. Then we'll make ICSI the method of choice for treating male infertility.*

MELANIE: *Think beyond that . . . to a wider vision of ICSI. I'm sure the day will come—maybe in another thirty years or even earlier—when sex and fertilization will be separate. Sex will be for love or lust—*

FELIX: *And reproduction under the microscope?*

MELANIE: *And why not?*

FELIX: *Reducing men to providers of a single sperm?*

MELANIE: *What's wrong with that . . . emphasizing quality rather than quantity? I'm not talking of test tube babies or genetic manipulation. And I'm certainly not promoting ovarian promiscuity, trying different men's sperm for each egg. Each embryo will be screened genetically before the best one is transferred back into the woman's uterus. All we'll be doing is improving the odds over Nature's roll of the dice. Before you know it, the 21st century will be called "The Century of Art."*

FELIX: *Not science? Or technology?*

MELANIE: *The science of A-R-T: assisted reproductive technologies. Young men and women will open reproductive bank accounts full of frozen sperm and eggs. And when they want a baby, they'll go to the bank to check out what they need.*

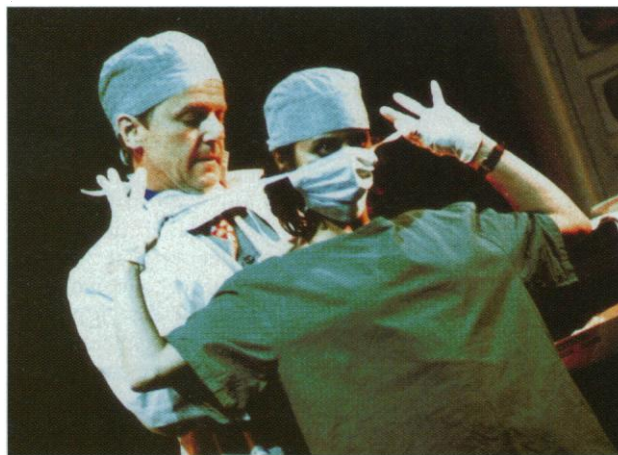
FELIX: *And once they have such a bank account . . . get sterilized?*

MELANIE: *Exactly. If my prediction is on target, contraception will become superfluous. (Pause) Of course it won't happen overnight . . . But A-R-T is pushing us that way . . . and I'm not saying it's all for the good. It will first happen among the most affluent people . . . and certainly not all over the world. At the outset, I suspect it will be right here . . . in the States . . . and especially in California.*

FELIX: *The Laidlaw Brave New World. Before you know it, the Pill will only be found in a Museum of 20th Century ART rather than a drugstore. And single women will use ICSI to become the Amazons of the 21st century.*

MELANIE: *Forget about the Amazons! Instead, think of women who haven't found the right partner . . . or had been stuck with a lousy guy . . . or women who just want a child before it's too late . . . in other words . . . women like me.*

ICSI raises many ethical and social issues. For example, once the effective separation of Y- and X-chromosome-bearing sperm has been perfected, ICSI will enable sex predetermination of the offspring with a high degree of success. For a couple with three or four daughters who would like a son, such sex predetermination may be of benefit to society, whereas it would be disastrous if practiced widely in societies that greatly favor male children over girls. Consider the capability of preserving the sperm of a recently deceased man in order to produce (through ICSI) a child months or perhaps even years later. Using the frozen sperm and egg of deceased parents would generate instant orphans under the microscope, a scenario with serious



Ready for action. Melanie and Felix prepare for the first fertilization of a human egg by ICSI in the Austrian production of *An Immaculate Misconception (Unbefleckt)* performed at the Jugendstil theater in Vienna, Austria, 4 to 7 June 1999.

implications for society. But it does not take much imagination or compassion to conceive of circumstances where the surviving wife might use the sperm of a beloved deceased husband so that she can have their only child. ICSI also provides an opportunity for men who are genetically infertile to become fathers. For example, men with congenital bilateral absence of the vas deferens who have no sperm in their ejaculate could become fathers by injection of immature sperm aspirated from the epididymis into the egg. But a compounding problem in such men is that they also may carry the cystic fibrosis genetic defect. Therefore, one could envisage a scenario in which such men could pass on both the infertility defect and the cystic fibrosis defect to their offspring, raising the specter of successive generations of males requiring ICSI in order to have children. These are intrinsically gray areas, and decisions about the applications of ICSI and other ART cannot be provided by scientists or technologists. The ultimate judg-

ment must be that of society—hopefully well-informed—which, in the case of sex and reproduction, really means the affected individuals.

Although these scenarios will be considered by many as “unnatural,” the successful doubling of the average life expectancy during this century in many parts of the world, which now ensures that women live longer than men (at least in affluent societies), can be considered just as “unnatural.” Now that people are living longer but healthier lives, a woman who becomes a mother at 45 could raise a child for much longer than was true for many 20-year-old mothers at the beginning of this century. Of course, motherhood at an older age is physically, psychologically, and economi-

cally suitable only for certain women, but at least the choice is now available in wealthy countries. The increased availability of ART is a characteristic of affluent, geriatric societies (such as those of Western Europe and Japan, where more than 20% of the population are over 60). But even within these countries, the cost of such reproductive technologies (frequently not covered by insurance) is such that only the more affluent citizens can afford them. Three-quarters of the world's population is represented by the pe-

diatric countries of Africa, Asia, and much of Latin America, where more than 40% of the population may be below 15 years of age and where contraception rather than conception will be the catchword for decades to come.

“The technique of reproduction detaches the reproduced object from the domain of tradition,” wrote Walter Benjamin in his 1936 essay, *The Work of Art in an Age of Mechanical Reproduction*. By replacing “the work of art” by “sex” and substituting “offspring” for “reproduced object,” it becomes clear that Benjamin's ideas could equally well apply to assisted reproduction. Detaching the child from traditional procreation may well be the most fundamental ethical issue raised by ART. Neither science nor the humanities have so far adequately prepared us for the consequences of sex in an age of mechanical reproduction, nor for the fact that the effective treatment of genetic infertility has made the uninherited heritable.

CREDIT: CLAUDIA PRIELER