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Can Research Be Forbidden?

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When I agreed to speak in Rome at the 2006 World Congress for Scientific Freedom on the topic ‘Can research be forbidden?’ I did know that Lewis Wolpert would speak before me. This led me to focus on a more personal aspect of my assigned topic because I more or less knew what his opinion would be and that I was likely to agree with his conclusions. I was sure that he would take care of logical arguments – flavoring them with the humor and emotion that I would not employ – concerning the common confusion between science and technology and the impossibility of forbidding scientific research, since that would be equivalent to banning human curiosity. Moreover, in basic scientific research one never knows what to forbid until it has actually been discovered. If one knew the answer ahead of time, he or she would not be doing research in science but in something else which may also be reasonable and even intellectually satisfying but something that is not basic research.

Since Wolpert’s chapter in this volume, as well as other contributions, cover these points, I shall start with an example from my own research – the development of oral contraceptives, with its components of basic research and subsequent applied technology – and then switch to the relationship between reproduction and sex and the impact of medically assisted fertilization on the consequent separation of coitus and reproduction. However, the manner in which I will present my conclusions will differ in one major respect from that of all of the other contributors to this volume. Over the last two decades, I switched my mode of communication from the standard academic discourse of scientists to fiction and, more recently, to play-writing. Readers may well wonder why a chemist would wish to write novels and plays. Quite simply, I wanted to become an ‘intellectual smuggler.’ I am interested in smuggling ideas, which I consider important, into the mind of a public that either does not know about these issues or does not wish to listen to them. So writing a standard scientific article, or giving a standard lecture, is really useless as far as the public that I wish to influence is concerned. People who go to such lectures or read such articles or chapters are already engaged in the topic. I want to engage the huge numbers who do not go to lectures or read academic

articles or are even afraid of them. Smuggling important ideas into their minds in the guise of fiction (using ‘science-in-fiction’ rather than science fiction) or through the medium of the theatre (‘science-in-theatre’) interests me greatly. Since, during the past dozen years, I have focused especially on the theatre, I shall end my chapter with relevant excerpts from two of my plays.

Let me start with one very important point. Certain circles, notably in Europe and the United States, now exert open pressure to forbid some kinds of research – with stem cells, cloning and genetic engineering of foods being typical examples – because they fear that such technological advances will deleteriously affect their current life style and values. Note that I speak about ‘technology’ since it is the application of research. It is technology, and not basic research *per se* (i.e. the search for new knowledge), that will impact on our lives, although, as Piccirillo¹ points out in this volume, basic research *per se* may also affect our lives rather directly, due to issues of resource allocation.

The fact that new technology frequently has an enormous impact on everyday life is, of course, true as demonstrated by the introduction of the computer or cell phones. But few seem to consider the opposite argument: that at times, it is social changes that create the demand for new technologies or make possible their rapid adoption. If such new technology is desired because of social changes but is not yet available, then societal pressure is exerted for doing the necessary research to eventually enable such technology to be exploited. In my opinion, sex and reproduction are excellent examples of this.

Sex and reproduction as relevant examples

Following this preamble, I am now ready to start with the contraceptive pill. Most people, when learning that I had something to do with its invention, say, ‘How do you feel about causing the sexual revolution of the 1960s?’

I would first qualify my answer by stating that I was associated with the first chemical synthesis of an oral contraceptive and not with the biology and subsequent clinical testing. Of course, it all had to start with chemistry since, without the actual chemical substance, no biological or subsequent clinical research could have been conducted. However, if I really have contributed to the sexual revolution, I would say that I am pleased but was the pill really the causative factor of the sexual revolution as so many insist? What really happened in the 1960s?

In that decade, four movements simultaneously flowered in the United States: drug abuse, hippie culture, the rock and roll music scene and, most importantly, the women’s movement. All four of them were different, yet all involved some sort of sexual liberation, if not increased promiscuity. What the pill did was to remove the fear of unwanted pregnancy. If social mores are simply to be maintained

through the fear of pregnancy rather than through some fundamental teaching of morality, then such mores are not worth maintaining. In other words, the pill greatly facilitated the sexual revolution, but the conditions for its use were ripe through the concurrent rise of these four social developments that had nothing to do with the actual technology of oral contraception.²

In fact, I have specifically raised³ the ‘what if’ question: if the pill had never been discovered, what would sex have been like in the year 2000? In my opinion, sexual behavior would not have been different in the period 1970 to 1985 prior to the AIDS explosion and the increasing concern about sexually transmitted diseases. What would have been different in the 1960s and 1970s, when abortion was still illegal in most countries, is that there would have been hundreds of thousands of illegal abortions. Preventing them was clearly one of the benefits of the pill, in addition to offering women the ability to control their own fertility in private by deciding whether and when to become pregnant. Some people claim that the pill was one of the worst things ever discovered.⁴ I obviously don’t believe that, and if I had to live my life over again, I would have done it in the same way with only one difference: encouraging the clinicians to have women be much more involved in the decision-making process at the very outset of the clinical studies. Their sidelining was largely due to cultural factors; at that time, particularly in the medical establishment, phallocentricity reigned – with most obstetricians and gynaecologists having been men.

Sex and reproduction were always linked throughout human history. It is not surprising that scientists in the late nineteenth and early twentieth centuries focused on endocrinology, on sex hormones, and really on how the entire human sexual reproduction process worked. In the 1920s, a physiologist in Catholic Austria, Ludwig Haberlandt, was the first⁵ to explicitly recognize that the female sex hormone progesterone is nature’s contraceptive: women do not become pregnant during pregnancy. Why? Because that is the only time when women produce progesterone all the time. Already in the 1920s, Haberlandt suggested that a progesterone pill be used for oral contraception in women.⁶

However since at that time progesterone had not yet been isolated or synthesized, he used glandular extracts containing progesterone and even coined a commercial name: Infecundin,⁷ but he died too early (1932) to pursue these plans – actually through suicide prompted by the relentless critique to which he was subjected in conservative Catholic Austria.⁸

A couple of years later, the structure of progesterone was established by chemists in Germany and then made available through synthesis. By the end of the 1930s, progesterone had already entered medical practice for the treatment of menstrual disorders and infertility, since there are women who can become pregnant but cannot carry the pregnancy to term because they do not produce enough progesterone to maintain the proper endometrial environment for the continuing development of the fetus. Even if Haberlandt had lived to pursue the contraceptive applications he predicted, he would have found that

they would not have worked since progesterone is not orally active. Hence the medical uses of progesterone that I just mentioned were all implemented by injection; and daily injections for contraceptive purposes would have been totally impractical.

Nearly twenty years after Haberlandt's death, in 1950, I was associate director for chemical research at Syntex, a small pharmaceutical company in Mexico City that was interested in developing new proprietary drugs related to steroids. One of the research topics we selected was the attempted synthesis of a steroid which does not exist in nature but which would mimic the biological properties of progesterone and be orally active. We accomplished that aim on 15 October 1951 by synthesizing a substance, norethindrone, which was more active than natural progesterone, yet effective by mouth.⁹

Why would one even think of prospectively forbidding such research, research that led to approval by the Food and Drug Administration (FDA) in the United States in 1957 of norethindrone for the oral treatment of menstrual disorders and the oral treatment of infertility? Or possibly even applicable to the treatment of cervical cancer – a possibility then under investigation? The answer is both obvious and foolish. Because norethindrone was subsequently also found to be the answer to Ludwig Haberlandt's dream of a contraceptive pill based on the properties of natural progesterone, and critics condemning such use wished that this Pandora's box would never be opened through the type of research we as chemists, and subsequently biologists and clinicians like Gregory Pincus¹⁰ and John Rock¹¹ performed.

FDA approval for extending the use of such synthetic steroids to oral contraception occurred in 1960 and within a couple of years two million American women were already using this method of birth control – a figure that no drug company or physician anticipated. It was primarily the desire of women to accept such a birth control method separated from the coital act rather than the companies' marketing skills that led to such a rapid rise in oral contraceptive consumers by the mid 1960s; a figure that has now reached the 100 million mark worldwide, with the pill being the most popular method of birth control in over seventy countries. Space limits do not permit me to delve into further aspects of the pill which I have covered in great detail in three books.^{12,13,14}

The divorce of sex from reproduction

I would now like to pursue a related topic that is currently the focus of my lectures and writing: the impending separation of sex and reproduction. Sex in the usual places and as usual motivated by love, fun, lust, or curiosity, but reproduction planned and, even more significantly, increasingly dependent on assisted reproductive technologies 'under the microscope.' The *de facto* separation of sex and reproduction is most dramatically illustrated by Catholic countries like

Spain or Italy where the average family now has 1.1 to 1.2 children. Surely many Spaniards or Italians have sex hundreds of times after they have had that small number of children without any intention of increasing the size of their family. The reasons have very little to do with the pill as demonstrated by the fact that the situation is not much better in Japan, where the pill was only legalized in 1999¹⁵, but rather with social, cultural and especially economic factors. Still, fertile people resort to ordinary unprotected intercourse to eventually have the one or two children that are now so common in these countries, but what of the total separation between coitus and fertilization, namely fertilization that takes place not in the bedroom but rather under the microscope in the absence of sexual intercourse?

This was realized in 1977 through the invention of in vitro fertilization (IVF) by Edwards and Steptoe in the United Kingdom and belatedly recognized by a Nobel Prize in 2010. As a consequence, during the past three decades, three or more million births have occurred without sexual intercourse to parents with impaired fertility. The proposition I would like to raise is that, in the future, increasing numbers of fertile people will resort to this approach and that this will be especially facilitated through an IVF procedure called ICSI (intracytoplasmic sperm injection) that was invented in 1991 by a group of Belgian researchers headed by André van Steirteghem.¹⁶

Science-in-theatre as a means of information transmittal

Instead of continuing in my present mode, let me now illustrate how I have smuggled this issue into the awareness of a general public through my play, *An Immaculate Misconception*.¹⁷

This title is not translatable into any other language. Only in English does ‘misconception’ mean misconception as well as ‘misunderstanding’. I emphasize this point because I do not want people to think that my title is meant as a blasphemous allusion to the religious concept of the ‘Immaculate Conception’ but how did I explain the meaning and mode of operation of ICSI in a theatre play? Let me illustrate this through excerpts from two scenes between ‘Melanie’ (a reproductive biologist who in my play is the inventor of ICSI) and ‘Felix’ (a medical colleague whom she wishes to enlist as a collaborator).

FELIX: *You said it was hot stuff.*

MELANIE: *It is.*

FELIX: *So let's hear it.*

MELANIE: *I finally managed to work it all out in hamsters.*

FELIX: *What's next?*

MELANIE (*triumphantly*): Fertilize a human egg! Just think of it: by directly injecting a single sperm!

FELIX: *Intracytoplasmic... sperm... injection.*

MELANIE: *Exactly! (Spells it out slowly): I...C...S...I... (Then quickly, as one word): ICSI. And if it works, that acronym will be in the next edition of Webster's Dictionary!*

FELIX: *ICSI even sounds like a kid's name... something that my patients can identify with. (Pause). If they knew what you were up to in here... they'd be breaking down your door. Men with sperm counts so low they can never become biological fathers in the usual way. They won't care if egg penetration is performed under a microscope or in bed... just so it's their own sperm.*

MELANIE: *Frankly, I was thinking of women... specifically this one.*

FELIX: *I can understand that. You'll be famous... world-famous... if a normal baby is born through ICSI. So far, of course, a big if!*

MELANIE: *Then forget about fame. What about ICSI and motherhood?*

Now that I have explained what the acronym ICSI stands for, let me illustrate through another brief excerpt from my play what this method represents operationally.

MELANIE (*bends over microscope*): *We've got seven first-class eggs harvested – all from the same woman. Let's see how I do with the first couple of eggs. If everything works out, I'll let you do the next two. I'll then finish with the rest. Here we go. Felix... would you start the VCR? I want you to follow on the monitor what I'm doing here under the microscope.*

(Felix pushes the button and turns toward the screen. Both are completely silent as the screen lights up. Melanie is hunched over the microscope, both hands manipulating the joysticks on each side of the microscope).

MELANIE: *Ah... here we are. (Startled). God, this sperm is low-grade stuff. But these two are swimming – a good sign....*

FELIX (*with sarcasm*): *Great... two real machos...*

MELANIE: *With my ICSI, I need only one.... But first I've got to crush its tail so the sperm can't get away... (Quickly moves pipette toward sperm and sounds jubilant as the injection pipette crushes the sperm's tail). Gotcha!*

FELIX: *Ouch! Be careful! I bet you hurt him!*

MELANIE: *That's what you think! Sperm have no feeling. Now comes the tricky part. I've got to aspirate its tail first.... As soon as I get close enough, just a little suction will do the trick.... (Screen image displays the sperm, tail first, being sucked into the pipette). Hah! Gotcha!*

FELIX: *Not bad! Not bad at all.*

(Silence for a few seconds until image of egg appears)

MELANIE: *Here we are. Isn't she gorgeous? Just look at her... my precious beauty... now stay still while I arrange you a bit... while I clasp you on my suction pipette... (Egg on screen is now immobilized in precisely the desired position for the penetration). Felix, now cross your fingers. (He leans forward, clearly fascinated. Injection pipette containing sperm appears on image but pipette remains immobile.)*

FELIX: *Just push the capillary in!*

MELANIE: *It's just doing the very first human ICSI experiment with this sperm into... this egg... (Melanie lets out audible gasp of relief as pipette penetrates the egg).*

FELIX: *(Makes sudden start, as if he had been pricked): My God! You did it! Superb penetration! (Image shows pipette resting within egg). Now shoot him out! (Points to sperm head in pipette).*

MELANIE: *Here we go. (Image shows sperm head at the very end of the injection pipette emerging on the screen from the pipette into the egg cytoplasm). Ah, that's a good boy. (Carefully withdraws pipette).*

FELIX (excited): *You did it, Melanie! Look at him... just look at him! Sitting in there. (Approaches image and points to sperm head on screen. Calmer voice). It's amazing. That egg looks... what shall I say? Inviolable, almost virginal.*

MELANIE (looks up for first time from microscope): *It better not be... I violated it very consciously and tomorrow I expect to see cell division.... Felix (points to VCR), turn off the VCR. (He does so).*

FELIX (turns accusatory): *But Melanie, whose crummy sperm are you using here? They were barely moving.... You could hardly have chosen worse.*

MELANIE (bantering): *I could have picked sperm from a dead man.*

FELIX: *Are you implying that ICSI could be used with such sperm?
Or are you just joking?*

MELANIE: *Just speculating. If the sperm from a dead fertile man is aspirated within a few hours post mortem... maybe even after 24 hours... just so we still have some twitching sperm... one could preserve such semen for months, if not years and then still use it for ICSI.*

FELIX: *And you think that's okay?*

MELANIE: *You asked whether ICSI fertilization with the sperm of a recently deceased man were possible and I said, yes. You didn't ask whether it was OK.*

FELIX: *I am asking now! Would you use a dead man's sperm and, I suppose, a frozen egg of a deceased woman to generate instant orphans?*

MELANIE: *No... I wouldn't go that far.*

FELIX: *But somebody else might.*

MELANIE: *Kids need at least one parent... preferably two.*

FELIX (ironic): *I'm relieved to hear that. (Pause). So who is the father?*

MELANIE: *There isn't any father in the usual sense of the word.*

FELIX: *An immaculate conception?*

MELANIE: *You know... in a way that's true. There was no penetration of the woman, no sexual contact. In fact, at that moment, there was no woman, no vagina... nor a man (pause)... The only prick (pause)... was the gentle one by a tiny needle entering an egg in a dish, delivering a single sperm. (Laughs). Even that prick was provided by a woman. (Pause). If this ICSI injection works... and we'll find this out in a couple of days... I want you to take the developing embryo, insert it into a woman... and then treat her kindly for the next 8 or 9 months until delivery of the baby.*

FELIX: *Where did this egg come from?*

MELANIE: *From me.*

FELIX: *What? Experiment on yourself?*

MELANIE: *Why not? It's not as if there isn't a tradition of self-experimentation in medicine.*

Clearly, this mode of presentation works. Since its premiere in 1998 my play has been translated into twelve languages as well as broadcast by the BBC (world service), WDR (Germany), NPR (USA) and the Swedish and Czech radio. While *An Immaculate Misconception* has not yet been translated into Italian, a pedagogic wordplay I wrote subsequently on this subject for use in schools has been¹⁸[15] together with a CD containing the just described ICSI injection. In 2004, this wordplay was presented by some Italian students at the Italian Science Festival in Genoa.

ICSI was invented in 1991 in Belgium for the treatment of male infertility associated with oligospermia (insufficient number of sperm) by the direct injection of a single sperm into an egg. Since 1991, it is estimated that 350,000 or more ICSI babies have been born throughout the world. Clearly the genie is out of the bottle and it is thus patent nonsense to attempt to forbid this in some countries, since it would simply breed medical tourism and thus reinforce the disparity between the rich, who can afford such reproductive travel, and the poor who cannot. Of course, the treatment of infertility in general may be an appropriate question for ethical debate: should one consider infertility a disease that merits treatment? Many societies have answered that question in the affirmative and the National Health Service in the United Kingdom even covers such treatment under its national health insurance. Yet one could argue that such treatment transcends evolutionary barriers that took hundred of thousands of years to create, and for very good reasons, but that fundamental ethical issue is beyond the much narrower focus of my current chapter and I shall not discuss it further.

Some of the uses of ICSI raise ethical questions that go way beyond the fairly straight forward one of whether infertility should be treated. An example is cited in the above play excerpt by referring to the possibility of using the sperm of a recently deceased man. In point of fact, this is not just a possibility but has actually been realized a number of times in recent years. It is only one step beyond the much more common occurrence of storing a man's sperm for months or years and then using it for artificial insemination even after the donor's death with his written permission. Should this be legally forbidden or left to individual choice? If that choice were available during the Second World War, is it not likely that many married soldiers would have elected to preserve their sperm as a form of reproductive insurance in case of death and should this be prohibited to his widow?

If such stored sperm came from a fertile man, it would not be necessary to use ICSI for the artificial insemination. Now let us proceed one step further and examine the question of sex predetermination. Here ICSI would be needed because only one sperm is used. The sex of the offspring is always controlled by the sperm, with a Y chromosome-containing sperm leading to a boy and an X chromosome sperm to a girl. The fundamental research in this field, notably the separation of X and Y sperm by flow cytometry, was performed in the cattle industry where the exclusive generation of either females (dairy industry)

or males (beef cattle industry) is associated with economic rather than ethical issues. I doubt whether there was any clamor to prohibit this type of animal research, but the technology is equally applicable to humans, and here we can easily visualize horror scenarios if this approach were to be used on a large scale in countries such as China or India where cultural factors would lead to a predominance of male babies with horrendous consequences. So what about the family that has three girls or three boys and only tries for another child because they wish for at least one of the opposite sex? Should such a technological application be prohibited? These issues have been covered in ethics literature.^{19,20,21,22}

Another case history from science-in-theatre

Here is an example of how sex predetermination was handled in another play of mine²³ that deals predominantly with some of the contentious ethical problems raised by assisted reproductive techniques. The speakers are Harriet, a physician who became pregnant by ICSI and donated some of the excess embryos to Cameron, a devout (and fundamentalist) Christian. Priscilla, Cameron's wife, is infertile and hence needed a surrogate embryo in order to give birth to a child of her own.

CAMERON: *How do you know they'll both be sons?*

HARRIET: *Because I wanted mine to be a son.*

CAMERON: *But that's no guarantee. God decides what we get and we'll be grateful for whatever blessing He bestows.*

HARRIET: *Cam, I don't want to argue religion with you. This is biology. (Beat). We used ICSI for the fertilization, right?*

CAMERON: *Right.*

HARRIET: *Injecting one sperm into each egg, right?*

CAMERON: *Right.*

HARRIET: *The sex of the child is always controlled by the sperm. A Y chromosome-bearing sperm leads to a boy, an X chromosome-bearing sperm to a girl. I'm sure you learned that in high school – even in Mississippi.*

CAMERON: *So what are you telling me?*

HARRIET: *That the technology... it's called flow cytometry... has now been developed to separate X – from Y – sperm –*

CAMERON (taken aback): *And you used separated sperm?*

HARRIET: *Yes.*

CAMERON: *And you didn't tell me?*

HARRIET: *That wasn't part of the bargain. You wanted to have a child with your wife. There weren't any more eggs of mine left for new ICSI injections. I was generous enough to give you the remaining embryos and all of those were potential males.*

CAMERON: *Jeez!*

HARRIET: *Cam, stop using that word. It's driving me crazy. And what's wrong with your having a boy?*

CAMERON: *Nothing.*

HARRIET: *You see!*

CAMERON: *But picking the sex of the child is so...*

HARRIET: *Don't tell me... unnatural.*

CAMERON: *Unnatural, yes.*

HARRIET: *And you think ICSI is natural? Most of modern medicine is full of interventions and materials that cannot be found in nature. You think 'unnatural' is automatically 'unethical?' (He falls silent). But I wanted to talk about something else.*

Perhaps the most interesting application of IVF may occur in the near future among more affluent and highly educated fertile women who postpone childbearing until their late thirties or early forties. Such women are not prepared to make an earlier decision between profession and childbirth, an option that women never had before because they were not allowed to exercise it. Now when all kinds of professional opportunities are open to them, they would like to have these choices as a question of elementary equity for women. Many of the more worrisome applications of ICSI have become women's issues even though the invention of ICSI was initially aimed at men's infertility. However, all too often these women forget that by their late thirties, 90 to 95 per cent of their eggs are already gone, the remaining rapidly aging eggs then

being associated with impaired fertility as well as genetic problems in their offspring (for example, greatly increased incidence of Down's syndrome). Since in IVF, and especially with ICSI, several eggs are fertilized, it is possible to screen through pre-implantation genetic analysis of a three-day embryo containing sixteen cells for mutations that hitherto were only detected by amniocentesis in the twelfth week of pregnancy with abortion then being the only resort. Again quoting from my play, TABOOS, here is the dramatic equivalent of the above factual information:

SALLY: *So you want a baby?*

HARRIET: *You really want to know? I'd like to start the procedure soon.*

SALLY: *How soon?*

HARRIET: *Well it's going to take at least two months' preparation because I'd like to use IVF. I just need to see how the superovulation will go. I'm now 37. Not too old to have a baby provided I'm fertile... but old enough to take precautions.*

SALLY: *You mean amniocentesis?*

HARRIET: *No... I don't want to take that route. Then... if anything is wrong... abortion would be the only alternative, because I'd already be three months pregnant. I'm opting for pre-implantation genetic screening of the embryos.*

The real issue with assisted reproductive technology is the set of non-scientific, social problems it raises with respect to parental rights. I shall illustrate a couple of these problems through two final excerpts from the play TABOOS. The first takes place between Max, the brother of Harriet, and Harriet, the mother of an ICSI baby. The sperm donor was Cameron, whose infertile wife, Priscilla, then received some of Harriet's excess embryos.

MAX: *Why, for heaven's sake, didn't you have some legally binding agreement with Cameron?*

HARRIET: *For what? For asking him to lend me a few sperm for injections into my own eggs?*

MAX: *'Lending?' It was an irrevocable transfer of title to property ... property that you made much more valuable as a consequence of the use to which you put it.*

HARRIET (*angrily*): *There was no agreement about that property being returned upon request! And when I gave him the rest of the embryos, it was a gift... an unrestricted gift. I didn't even want to know what he'd use them for.*

MAX: *How could you not want to know?*

HARRIET (*increasingly angry, bordering on guilt*): *For me, an embryo in a Petri dish or in a freezer is an abstraction... a clump of 8 or 16 or 32 cells... nothing more, It's only when that abstraction is transferred into a woman and implants are we dealing with reality. And I was focusing on my own uterus...*

MAX: *Some legal journal will have a field day, reporting this if it ever comes to trial.*

The final excerpt between the fertile egg donor, Harriet (mother of Jan) and Priscilla, Cameron's infertile wife and now mother of Ashley emphasizes the problems of the definition of 'motherhood' between a biological and surrogate mother:

PRISCILLA: *It was your embryo... but my baby.*

HARRIET (*sardonic*): *Why don't you go back to the Internet to see what you can find under 'genes'?*

PRISCILLA: *I don't need the Internet to tell me about my child. For nine months, Ashley and I formed a relationship. You understand? A relationship that'll last until death! I talked to Ashley while he was in me... when you didn't even know what had happened to your embryo! Sure, I'll always be thankful to you for that gift... but I'm not just an incubator for your embryo. Ashley is my child. He's been baptized (Almost hysterical). Baptized! Do you hear that? This child was born again when he was 10 days old!*

HARRIET: *Whatever. I hope you don't think you have any rights to my child?*

PRISCILLA: *To Jan? No... I don't have any.*

HARRIET: *Well that's a consolation.*

PRISCILLA: *But Cameron's the father, so you'd need to check with him.*

HARRIET (*explodes*): *I see. You think I have no rights with respect to Ashley as the egg donor, but your Cameron's puny little sperm will give him rights to my son?*

Rather than continuing, let me summarize what I have attempted to accomplish in this chapter. While research in reproduction opened up possibilities for technological advances that are now creating a host of complicated problems, most of these are associated with societal changes of women in the more advanced industrialized countries. These revolve around individual choices – choices of women and choices of couples – that in my opinion are not controllable by legislative or religious edicts (if they were controllable, why does the highest number of illegal abortions occur in Catholic Latin America where both the governments and the Church prohibit it?). The technological advances in assisted reproduction that occurred during the past thirty years were hardly predictable, so how could the underlying research have been prohibited? I also wanted to illustrate that non-orthodox methods of information dissemination – such as my choice of ‘science in-theatre’ plays – could play a useful role in raising the intellectual level of public debate which these days is so sorely needed.