

# Environmental Review

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## President Bush Reinstates the Gag Rule

Introduction:

The United States provides about 43 percent of the money used to support international population assistance, programs that include family planning, maternal and child care, and sexually transmitted diseases such as HIV/AIDS. One of the first actions of the Bush administration in 2001 was to reinstate the Mexico City policy, which denies USAID funds to any foreign family planning or health organizations that provide abortion.

In underdeveloped countries abortion is a serious public health issue: about 70,000 women die each year as a result of unsafe abortions. The Mexico City policy means that countries where abortion is permitted more liberally than the US would like, countries like India, Bangladesh, South Africa, Russia, and many others, must close their abortion services or lose USAID funding. Women in those countries can still get an abortion but must use non-USAID supported services, which means second rate medical care at best and at worst, unsafe abortions. The American College of Obstetricians and Gynecologists has written that the Mexico City policy "violates basic medical ethics by jeopardizing a health care provider's ability to recommend appropriate medical care."

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We spoke with Barbara Crane about U.S. family planning assistance overseas and the consequences of the Mexico City policy on women's health.

**ER:** Dr. Crane, what is your job?

**BC:** I am currently Executive Vice President of Ipas, a nonprofit international nongovernmental organization that works globally to advance women's reproductive health and rights. Our support comes from both private foundations and European governments.

**ER:** What is your academic background?

**BC:** I hold an M.A. from the Fletcher School of Law and Diplomacy at Tufts University and a Ph.D. in political science and world politics from the University of Michigan. My academic work was sparked by my strong interest in the potential for international cooperation to promote economic and social development. I focused on the population issue in the early 1970s and have written extensively on the political and policy issues surrounding efforts to stabilize the world's population.

I joined Ipas in July 2000; prior to that I worked for eight years in the U.S. Agency for International Development (USAID) helping to manage international family planning assistance. I was also very much involved in shaping U.S. participation in the International Conference on Population and Development held in Cairo in 1994, and in U.S. follow-up to the Program of Action adopted by governments at the Cairo conference.

**ER:** Could you say more about the Cairo conference and why it was important?

**BC:** Cairo was a landmark event in the history of international cooperation on population issues. It created a new framework for policies and programs that focus on women's reproductive health and rights as the key approach both to address the health needs of women and ultimately to achieve world population stabilization.

**ER:** Is it correct to say that the Cairo meeting was a cultural export of the United States? I'm referring to the struggle for women's equality.

**BC:** Some people see it that way, and I would agree in part. I might also say that to the extent the Cairo conference was a cultural export, it was a positive one. But it is important to recognize that the movement to mobilize women on their own behalf and to advance their equality and participation in the political process is happening around the world, it's not just a U.S. phenomenon, and that was true in the Cairo conference too.

**ER:** It seems like a natural extension of what's gone on in this country for the last 100 years.

**BC:** I think that the consensus in Cairo was reinforced by the movements in the United States for women's equality and by the involvement of women's nongovernmental organizations (NGOs) in the United States. These groups linked up with women's NGOs in developing countries to promote the new agenda for population programs that was reflected in Cairo.

**ER:** Was there a backlash from those sectors that would resist women's equality?

**BC:** There was an immediate backlash at the time of Cairo from Catholic and Muslim fundamentalists during the

negotiations at the conference and in the wording of the final agreements. That opposition from religious fundamentalists has continued to the present day.

The reaction also happened in the United States with the Right to Life movement that has been very critical of international family planning programs. They've been particularly concerned about the role they believe these programs play in promoting abortion.

**ER:** I wanted to go back to before the Cairo meetings and talk a bit about the history of USAID in international population efforts. Has that been sensitive to changing administrations?

period and is one of the main success stories in American overseas assistance.

**ER:** Cairo seems to be the watershed. Can you characterize family planning before that time? What were its goals?

**BC:** The major goal of U.S. involvement in international family planning programs has been to promote voluntary use of modern methods of contraception by couples in developing countries, working both with local governments and nongovernmental organizations. U.S. assistance, more than that of other donors, has focused on promoting the role of private organizations in providing services. Those organizations are often closer to

the community and more efficient and effective in providing reproductive health services.

So that's important background, in fact, to the issues around the Mexico City policy, the new policy of the Bush administration that foreign NGOs receive-

ing U.S. family planning assistance may not provide abortions even when the abortions are legal and paid for with private resources, and may not advocate for less restrictive abortion laws, even using non-U.S. funds. As a major donor and a donor that works significantly through nongovernmental organizations, establishment by the United States of a restrictive policy like the Mexico City policy interferes with the private activities of NGOs and has very far-reaching effects.

**ER:** How much money do we spend on family planning assistance?

**... foreign NGOs receiving U.S. family planning assistance may not provide abortions even when legal and paid for with private resources, and may not advocate for less restrictive abortion laws, even using non-U.S. funds.**

**BC:** Actually, U.S. involvement in international family planning programs goes back to the late 1960s and has been a major component of U.S. international assistance for all of these years, through both Republican and Democratic presidential administrations. The administrative leadership in USAID by and large has been nonpolitical, involving people primarily with public health backgrounds. The USAID family planning program has also been blessed by considerable continuity of leadership over this

**BC:** It has been an increasing amount since the beginning, although growth in the demand and need, because of the growth of numbers of women of reproductive age, has also been significant, so the growth in resources is not as great as it might appear to be just looking at the nominal amounts of funds. For the last six or seven years, the average amount of U.S. funding for international family planning has been around \$400 million a year, an amount that has gone up and down as a result of political events and changes of administration.

**ER:** Do the other developed countries also pitch in?

**BC:** Yes. Some other countries actually give a larger percentage of their foreign aid to family planning and reproductive health programs, especially the Scandinavian countries. The U.S. gives the largest absolute amount, and it is a significant percentage of U.S. development assistance, but U.S. development assistance performance is much lower than almost any of the other developed countries. We are at or near the bottom in the percentage of our Gross National Product that we devote to international assistance, less than two-tenths of one percent.

**ER:** What changed after the Cairo conference?

**BC:** Before Cairo, U.S. and other donor support for family planning focused on a demographic rationale for supporting these programs. They were seen as programs designed primarily to reduce fertility and population growth rates, because it was believed that rapid population growth was a critical factor in economic development and

protection of the environment.

What changed in Cairo was the understanding that programs that are built around a demographic rationale may not actually serve the needs of women in the best way and may ultimately be less effective than programs that take a more holistic approach to women's reproductive health needs and an approach that is



**Family waiting for services at a family planning clinic in Benin.**

Photo: M. Noguera, FPLM/JSI

more social change oriented. Following Cairo, the U.S. and other donors increasingly saw the benefits of mobilizing communities and people beginning with their own local concerns, rather than coming in from the outside with a preestablished agenda.

One of the interesting and innovative approaches that has emerged since Cairo is to integrate reproductive health programs with environmental programs at the community level and help people to see the linkages among fertility, reproductive health, population growth, and sustainable development in their own communities. Implementing such programs is challenging, however, and difficult to do on a large scale.

**ER:** I would think another place to work would be in improving the educational system. Universal education is a basic tenet of American progressivism.

**BC:** Exactly. And Cairo put a lot of emphasis on the importance of education at all levels and through all media, to better inform people. Implicit in the Cairo Program of Action is faith that when people are better educated and better informed they will make appropriate reproductive decisions.

**ER:** How does that translate in a practical way?

**BC:** Maybe Bangladesh is a good example. Pre-Cairo, family planning programs emphasized the role of village-level workers, who would go door to door in communities and talk to women to persuade them to use family planning and then provide them with contraceptive methods. So they would bring pills and condoms, for example, directly to women in their homes.

In fact, a lot of progress was made with this kind of approach, but at a certain point it reaches a plateau of effect. In addition, many people became concerned that women in

Bangladesh and other developing countries have a wide range of reproductive health needs. Many have reproductive tract infections, and maternal mortality is still very high in Bangladesh and elsewhere. It was recognized that it would be better to change the program strategy and provide clinical reproductive health services closer to women in their communities, and also to develop a more innovative educational approach that works through community organizations. Involving women in income-generating projects and providing micro-credit lending so that women can start small businesses of their own is a way to help them realize the benefits of lower fertility and gain more access to income, employment, and educational opportunities. Such programs help bring women out of their homes rather than just accept the gender inequality that earlier dictated that women in Bangladesh stay at home in traditional roles.

In sum, the preferred approach now is to try to address some of the causes of gender inequality and work at the community level to address a wider range of needs, including environmental threats, rather than focusing on one intervention. By combining programs and interventions, the hope is to help meet these other needs while also increasing the motivation for use of family planning.

**ER:** I'm sure someone at some point may have pointed out that that is

profoundly revolutionary in some societies.

**BC:** Yes, it is.

**ER:** I guess that gets back to my backlash question before.

**BC:** With regard to backlash, I probably should have continued my response a little earlier, that following the Cairo conference there was a Republican Congress elected in 1994 with leaders who were quite unsympa-

planning assistance found that it was a very easy target because it lacks a broad constituency in the United States. Attacking international family planning as well as the Cairo Program of Action was another way to appeal to conservatives and Right to Life organizations and groups in the United States.

**ER:** That's a lovely irony. When I was saying the Cairo approach was subversive I was thinking of other countries not our own.



**A child receiving oral polio vaccine drops in a refugee camp at the Thai-Myanmar border (1994).**

Photo: Paula Nersesian, FPLM/JSI

**BC:** Absolutely.

**ER:** It's political suicide to be on the wrong side of women's rights in this country.

**BC:** Right. But you see this dynamic to this day in international policy arenas. There's going to be a World Summit on Children in May 2002 to review progress with programs for children's health and welfare over the last ten years or so since the previous World Summit on

Children. In preparatory meetings, the Bush administration has aligned itself closely with Muslim fundamentalists and the Vatican in opposing progressive language on reproductive health for adolescents.

**ER:** I remember Newt making some hay out of that.

**BC:** Yes, and also unsympathetic to international cooperation, and the United Nations system. Congressional opponents of international family

**ER:** Could you briefly retrace some of the history of U.S. policies before the Bush administration and how we got to where we are today?

**BC:** The Cairo conference was one of the first major international events under the Clinton administration. One of Clinton's first acts as President was to rescind the Mexico City policy, which had been introduced by Ronald Reagan in 1984 at the World Population Conference that preceded Cairo. These conferences happen every ten years. In 1984, the International Conference on Population was held in Mexico City, and the Reagan administration took that opportunity to oppose population programs and announce a policy under which any organizations involved in abortion would no longer receive U.S. funding.

The Mexico City policy led to defunding of the International Planned Parenthood Federation, which was and is the largest network of private organizations providing family planning services around the world.

That policy remained in effect until 1993, when Clinton rescinded it, restored funding for the International Planned Parenthood Federation, and also restored funding for the UN Population

Fund (UNFPA), which under President Reagan was also defunded because of claims that UNFPA was contributing to coercive population programs in China. But the Clinton administration took the position that the role of UNFPA and other international organizations was actually to help alleviate the impact of the policy in China and influence China to take a more humane approach.

**ER:** Was there substance to the charge of coercive practices in China or was it politics?

**BC:** There absolutely was and is substance to the charges of coercive

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practices in China around family planning. But the question of the role that UN agencies play is a different one, and many people believe that UN agencies are playing a positive role. The current UNFPA program in China is working in a number of counties to try to create model voluntary family planning programs.

**ER:** The one-child policy seems to be

**ER:** You gave a broad statement of what the Mexico City policy was. Is it simply that no U.S. dollars can be used for anything associated with abortion?

**BC:** Actually, it's more complicated than that. The key feature of the Mexico City policy is that funds cannot go to organizations that use their own funds for abortion-related activities.

There has long been a rule applied to U.S. international family planning called the Helms Amendment, which precludes any U.S. funds from being used directly for abortions, so that has never been the issue. There is no evidence that any U.S. funds have ever been used for abortion activities.

**... the Bush administration has aligned itself closely with Muslim fundamentalists and the Vatican in opposing progressive language on reproductive health for adolescents.**

working, and the incentives that they use are pretty stringent. Is it more than that? Are women being forced to have abortions?

**BC:** In the 1980s people believed that the implementation of the Chinese policy was quite draconian in some instances and did involve forcible abortions. There seem to be many fewer allegations of that kind recently, so while there are strong incentives and disincentives associated with the Chinese policy, it doesn't appear that the more extreme forms of coercion are being tolerated by the government.

So the point of the Mexico City policy was to disassociate the United States from organizations that might be involved in abortion with their own resources. Because the United States is a major donor and there are nongovernmental organizations that depend on U.S. funds, this requirement puts them in a very difficult position of having to choose between receiving U.S. funds for family planning or fulfilling what they may regard as their commitment to meeting the full range of women's reproductive health needs and providing abortion as a legal service in their own countries. Whatever choice is made, some women will lose.

**ER:** Are there other effects of the policy on NGOs?

**BC:** Yes, this policy also puts them in a position where they cannot participate in democratic debates in their own countries about abortion policies and regulations. And that is why the Mexico City policy is also called by its opponents the global gag rule. It is a policy toward NGOs that is contrary to fundamental American principles and that would be unconstitutional if it were implemented in the United States. It also creates a double standard between U.S. organizations and NGOs overseas, as U.S. organizations are not limited in what they can do or say about abortion.

**ER:** Even with federal money?

**BC:** Yes, even those receiving USAID funding. So, for example, Pathfinder

International, which is a major USAID-funded organization based in Boston, can legally do or say what they want about abortion issues with the private funds that they have, but the grantees supported by Pathfinder with USAID funds are being told that they cannot talk about abortion.

**ER:** Does the Mexico City policy allow any flexibility, say, for a pregnant woman who has severe health problems?

**BC:** The policy would allow abortions in the case of a woman's life being in danger, or if she is a victim of rape or incest. But if there are other health reasons for her not to go ahead with the pregnancy, the policy would not allow a doctor to provide her advice or counsel her about her options. So the

only way that an abortion could legally be provided would be in a case of a life-threatening medical emergency or sexual violence, which is often hard for women to prove.

**ER:** Is there any information on the impacts of the Mexico City policy on health care?

**BC:** The key message of the recent article in *Science* that I coauthored with Richard Cincotta is that careful studies are needed in countries affected by the policy, as the full effects will not necessarily reveal themselves in a dramatic and visible way. However, we are beginning to learn of local organizations that are refusing to

**ER:** What was the impact of this policy first time around in 1984?

**BC:** Back in 1984 it was a different situation. There were only a couple of organizations (one of them being the International Planned Parenthood Federation) that refused USAID funds. At that time there were not as many NGOs involved in U.S. programs or as many NGOs involved in abortion-related services and advocacy.

One of the effects of Cairo, in fact, has been to raise the attention given to unsafe abortion as a major public health problem. We now know that 20 million women around the world experience an unsafe abortion every year — that's about forty every minute

— and more than 70,000 women die each year due to unsafe abortions. The Director-General of the World Health Organization, Gro Brundtland, recently drew attention to this problem in an

interview with the editor of *Foreign Policy*, where she stated unequivocally that when abortion is legal, women should have access to it, and that we should at least decriminalize abortion.

Awareness of this problem is also greater in many countries, and more than forty countries now have programs to at least treat the complications of unsafe abortions. Many of these programs have been supported by U.S. funds, which is a good thing.

**ER:** That is, once a woman gets in trouble, then we'll help her.

**BC:** Yes, but it's a very sad thing. In fact, we have a wonderful quotation from one of our partners in the Kenyan Ministry of Health, who said that providing post-abortion care is like

**...every year 20 million women around the world experience an unsafe abortion and more than 70,000 women die each year due to unsafe abortions.**

accept USAID funds on these terms. In Kenya, for example, the result is that some clinics serving very low-income people in the slums of Nairobi are being closed because the organization that provides services there will not accept these limitations and therefore will not be receiving USAID funds.

In other countries such as Albania and Nepal, NGOs that have accepted the USAID conditions are silencing themselves and avoiding discussions of national abortion policies or reproductive health service guidelines. I should also note for the record that my own organization, Ipas, is one of only two U.S.-based NGOs that has turned back USAID funds for postabortion care programs that would require us to impose restrictions on our local partners overseas.

trying to mop the floor when the tap is broken. "We say we don't want to fix the tap, but we keep mopping and mopping and asking for more mops." Of course, what you really need to do is go back and fix the tap, and we're not doing that yet.

**ER:** But for that interlude from 1994 until 2001, then we were actually trying to fix the tap, as it were? Is that correct?

**BC:** Yes, the Clinton administration made efforts to change attitudes on abortion, while staying within the legal boundaries set by the Helms amendment. And actually, programs to treat incomplete abortion do

continue to grow even under the Bush administration, and that's a good thing. It must be acknowledged

that the White House, in announcing the Mexico City policy, has restated and reaffirmed explicitly the administration's commitment to continue to support post-abortion care programs. They also have stated a commitment to continue to support family planning, so their policies have been good to that extent.

However, they are closing their eyes to the human costs of a restrictive approach to abortion in countries where many women have unwanted pregnancies, lack adequate access to modern effective methods of contraception, and are put in a position where they feel they have no choices.

**ER:** There seems to be this rather hopeful development coming out of the Cairo approach with more active

involvement of communities and efforts to advance women's rights around the world. Do you feel that the Bush administration is carrying forward the broader principles and goals of Cairo or subverting it?

**BC:** I think there's evidence that the Cairo approach will not be promoted by the Bush administration. The foreign aid program is in the process of being reorganized, and the full consequences of that are yet to be seen.

Philosophically, there's no evidence that the current political-level leadership in USAID shares the principles and goals of Cairo around women's rights, reproductive health, and the

be negatively affected under the current circumstance.

So at this point, what we have to be concerned about is a combination of the ideological direction of the current administration and the recent events, which means that it is going to be all the more important for people to continue to speak out on the need for U.S. involvement in environmental and population programs.

The countries and the women who are most affected by the Mexico City policy are the countries where the U.S. has historically had an important role to play in providing family planning and reproductive health services. That includes

countries like Bangladesh, India, Nepal, Kenya, Ghana, Haiti, Bolivia, and many others. These are countries that also face

high levels of poverty, deteriorating natural environments, and uncertain longer-range prospects for sustainable development.

We have to be concerned about any policies, such as the Mexico City policy, that impede efforts to address the serious problems that these countries have. And ultimately, we should reject a policy that is just completely inconsistent with the principles that Americans hold most dear: the right to free speech, and participation in the democratic process.

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**The Mexico City policy is contrary to fundamental American principles, it would be unconstitutional if it were implemented in the U.S.**

need for environmentally sustainable development.

**ER:** How would you sum up where we are today and what is at stake with the current policies?

**BC:** At the same time, we have to be concerned that the world situation post-September 11<sup>th</sup> will result in reallocation of resources to security-related objectives and high profile global disease control programs. Fewer resources may be available for community-oriented development efforts, democracy building programs that were emphasized under the Clinton administration, support for the growth of civil society in countries, and programs to advance the status of women and address their reproductive health. All of these efforts are likely to





## Humans Are An Evolutionary Force

### Introduction:

Evolution is probably one of the most disturbing ideas to have come along in the short history of our species. Darwin realized how upsetting it was to Victorian sensibilities and held back publication of his work for many years. Biologists are now comfortable with the idea that species have evolved, and most have gone extinct, over the course of millions of years.

In his new book, *The Evolution Explosion*, Stephen Palumbi shows how humans have dramatically accelerated evolutionary change in other species: human disease organisms like the HIV retrovirus and the staph bacterium; and at larger scale, in numerous insect pests of crops. Proof of evolution, if any further were needed, is seen in the now routine appearance of drug resistance by bacteria and viruses that formerly did not have resistance. Pesticide resistance also routinely evolves in agricultural pest insects. The result is an evolutionary arms race: we develop antibiotics and pesticides and use them for a limited time, their targets evolve resistance and we then need to fabricate new poisons. We can slow down the pace of this arms race, and reduce its cost, by using our knowledge of how evolution works.

We spoke with Professor Palumbi about how the evolution of resistance affects people and society.

**ER:** Professor Palumbi, what is your training?

**SP:** I was a graduate student at the University of Washington in Seattle, and got my Ph.D. from the Department of Zoology in Marine Ecology. I did my postdoctoral work at the Department of Biochemistry at U.C. Berkeley; I spent twelve years on the faculty at the University of Hawaii; and I've been here at Harvard as a professor of biology since 1996.

**ER:** What is the starting point for your book?

**SP:** The publication of Rachel Carson's *Silent Spring* and a whole generation of work that's followed has

process that takes millions of years, it can happen so quickly that species can change over much shorter time scales, so quickly that it is turning around and more or less biting back; that is, our own lives are directly influenced by the evolution of some of these species.

**ER:** For example?

**SP:** The evolution of antibiotic resistance in bacteria over the last fifty years is a good example. The first major industrial scale antibiotic was penicillin and it came on the scene in 1943. Since then practically every single major human infectious disease has evolved resistance to penicillin.

For example penicillin treated virtually all of the staph infections in the 1940s and early 1950s, but by the early 1960s so many staph infections were resistant to penicillin that doctors all over the world switched to a different drug, methicillin, instead. Just in that fifteen years after World War II bacteria evolved the ability to resist penicillin, making it much less effective and requiring the search for a new drug to take over from it.

**... 20 to 50 percent of the chicken pieces and ground meat that they purchased in the stores had live infections of human disease bacteria, and the vast majority of these bacteria were already resistant to antibiotics.**

alerted people that human beings are having massive ecological effects on the planet. We're now quite comfortable with thinking about how we're changing the ecology of the species around us, but our impacts are not limited to their ecology but in fact we are changing their evolution as well.

**ER:** People are used to thinking about evolution taking millions of years.

**SP:** Simple examples show that evolution is not only just a slow

We have seen this time and time again: when we use an antibiotic massively to treat a particular disease, then the bacteria that cause that disease become resistant to it, they evolve the ability to either destroy the antibiotic or to live in high concentrations of it.

**ER:** How does resistance evolve?

**SP:** Mutations naturally occur as the bacterial population grows, and some of those mutations may confer perhaps a slight resistance to an antibiotic. That



slight resistance allows that bacteria to persist longer during the antibiotic treatment than the other bacteria around it. Over time the bacteria that are the most sensitive to the antibiotic are killed and the bacteria that are the least sensitive persist.

If you get a ten-day dose of an antibiotic for instance, and you only take two or three days of it because you feel better, then the bacteria that have survived that short antibiotic course are left in you and then they can begin to multiply after you stop taking the antibiotic. Well, that population of remaining bacteria also has some variation in it and over time as the same selective force is applied to these bacteria in different people or even the same person in multiple bouts of using antibiotics, the resistance gets stronger.

From a population that has a little resistance to a population of bacteria that has a lot of resistance depends upon how you're treating the disease. If you kill all of the bacteria with a strong dose of antibiotic, then resistance doesn't happen quite so quickly. But if you treat only partially, then enough of the partially resistant bacteria survive that the evolution of resistance can take off.

**ER:** What about livestock being fed antibiotics?

**SP:** That is just about the worst scenario you can imagine. Livestock are fed a low dose of antibiotics not to cure them of diseases but to prevent epidemics in livestock that are grown in crowded conditions. Giving livestock antibiotics increases their growth

rate, so small doses of antibiotics are commonly used as growth enhancers. Those low doses don't kill many bacteria, but they do exert a selection pressure for the bacteria to evolve resistance. As a result livestock are intensely colonized by bacteria that are resistant to the antibiotics that they're being fed.

A recent set of papers in the *New England Journal of Medicine* looked at meat products bought in supermarkets around the country<sup>2</sup>. They looked at chicken pieces and at ground meat, and 20 to 50 percent of the samples that they purchased in the stores had live infections of human infectious disease bacteria. And the vast majority of these disease bacteria were already resistant to antibiotics.

**ER:** What's the connection to people?

**SP:** These animals, particularly cattle and pigs, harbor the same bacteria that

**HIV evolves so quickly that it doesn't take fifteen years like it did for penicillin resistance to become so common, it might take six months, and it happens so rapidly that drug resistance happens with every single person who gets the disease.**

also can grow in us. They're being fed the same antibiotics that we use for medicines. As a result, what we're getting in our supermarkets are meat products that are already prepackaged with drug-resistant disease organisms.

**ER:** I seem to remember someone who has been crying in the wilderness about this for a long time.

**SP:** Stuart Levy has been one of the main sources of this information. He's demonstrated since the 1970s that this

was a problem, and it simply hasn't been addressed as a public health issue until lately. And it's only been frankly when the disease organisms that are passed by meat have become so virulent that they kill people; for example, this strain of E. coli that has been traced to undercooked meat and is frequently fatal when it's encountered, it's only those kinds of cases that have caught the public attention and have demanded some cleanup to be undertaken.

**ER:** What should we do about this?

**SP:** Finland has banned the use of antibiotics in livestock rearing as an experiment to see if it was economically feasible to raise livestock without the benefits of antibiotics, and it appears to be working just fine. So the strong reaction would be to ban antibiotic use in livestock farms except in the case of treating different disease outbreaks.

A slightly less onerous change would be to say that there would be certain antibiotics that could be used in livestock and those wouldn't be used for humans; that is, to separate the antibiotic world into animal production chemicals and human

health chemicals.

**ER:** Humans are affecting evolution because we're dealing with small organisms that have a short life span compared to our own.

**SP:** That's right, and we see the strongest evidence of human impact on organisms that do have relatively short generation times, like bacteria or viruses like HIV.

The good thing about this news is that, although it's a serious problem,

we understand pretty clearly the way evolution operates. Evolution requires three things in order to operate at good efficiency. One is that there has to be variation in the population. The second is that that variation has to affect some component of fitness — survivorship or reproductive success or something like that — so that the variation is linked to the ability of organisms to have offspring in the next generation. The third requirement is that parents pass these variable traits on to their offspring, so that the offspring of individuals tend to be like their parents in that trait.

Whenever you have those three things — variation, variation that affects fitness, and the inheritability of those traits — then you've got the potential of the population to evolve by natural selection.

**ER:** How does this affect HIV?

**SP:** Evolution affects HIV in exactly the same ways it affects disease bacteria. HIV has a fast generation time and it also has one of the fastest mutation rates of anything we know, it mutates about 10,000 times faster than we do. As a consequence, when HIV infects a person, it quickly diversifies by mutation into not just a single disease but into a whole swarm of slightly different diseases. We call them all HIV and they have the same

fundamental properties, but they vary enormously in almost every gene that they've got.

When a person gets HIV their immune system starts to work on it and it does a good job at getting rid of HIV. Unfortunately, the immune system



**Rachel Carson pointed out the deadly effects of DDT on birds.**

targets just the first HIV that enters the person, and then the variations in HIV change the way the virus looks to the immune system.

The immune system might wipe out 90 percent of the virus in the first wave, but it leaves 10 percent behind and that 10 percent has mutated so that the immune system can't see it. Eventually the immune system

reacts again and sees that 10 percent that's left but by that time the virus has grown and mutated again.

In this case, the human immune system is the selection force on the HIV, so the population evolves quickly within an infected person, essentially running away from their immune system until finally it collapses. That is what's called seroconversion and that's when full-blown AIDS sets in. That's when we start treating HIV with drugs and we get the same situation: the drug treatment causes HIV to evolve resistance. HIV evolves so quickly that it doesn't take fifteen years like it did for penicillin resistance to become so common, it might take six months, and it happens so rapidly that drug resis-

tance happens within every single person who gets the disease.

For example, AZT is a drug that's cheap, it does a good job at stopping the replication and the growth of normal HIV, but within about six to ten months everyone who takes AZT no longer gets any benefit from it. That's because the virus within them has evolved resistance to that drug just in the previous six to ten months. HIV is so good at this that there isn't a single drug treatment that HIV hasn't conquered.

**ER:** How do we treat HIV now?

**SP:** Right now we treat HIV with a triple-drug cocktail that's so strong the virus can't grow. Even then we're not curing the disease, we're just stopping it from growing and stopping it from evolving. The good thing is that by stopping it from evolving we are keeping it static, and the triple-drug therapy has been successful for longer than any other that we've ever devised. But it's still not a cure, we've just been given a reprieve here until a different cure can be invented.

**ER:** So HIV is just evolving at a slower rate?

**SP:** That's right.

**ER:** So it's just a matter of time.

**SP:** It seems that way. Over the last five years where triple-drug therapy has been common in this country, the incidence of triple-drug resistant HIV is going up, so you're exactly right, it hasn't stopped the evolution of HIV. It has slowed it enormously, and that's the good news, the bad news is that it's not cured and it's not stopped from evolving, so we don't have forever.



**Cattle are given low doses of antibiotics in feedlots to prevent diseases and enhance growth, providing ideal conditions for the evolution of antibiotic-resistant bacteria.**

**ER:** Why does the immune system collapse?

**SP:** Because HIV attacks the cells that generate the immune response. Viruses live by infecting cells, taking them over and then using the cellular machinery to make new virus. If you have a head cold, the virus is in your nasal epithelia and those are the cells that it's feeding on. HIV does the same thing except it's not feeding on your nose cells, it's feeding on the cells that generate your immune response. So every time there's a round of HIV replication and the immune response comes in and knocks it down, the whole immune system is losing part of its army. Eventually all of the cells that could be used in that response are destroyed. That's why AIDS is called the Acquired Immuno Deficiency Syndrome, because your immune system has been so devastated that you can't respond, not only to HIV but you can't respond to other diseases either. People don't die of HIV, they die of other diseases.

**ER:** What sort of policy implications does this have?

**SP:** The environmental policy issue about that is we use triple-drug therapy in this country, which costs about \$20,000 per year per person. Many other parts of the world that have higher incidences of HIV than we do are much poorer, and they simply can't afford those costs.

The danger in the way you might think about HIV in southern Africa is you might say, Well, we can't afford triple-drug therapy, but we could afford some AZT so let's just go ahead and use that because it's such a major health crisis and that'll be better than nothing.

It is a major health crisis, but the evolutionary biology predicts clearly that if you go into another country with sub optimal HIV treatment, the virus will evolve. We can't afford to treat other people differently than we treat ourselves and the cost of triple-drug therapy somehow has to be borne because there isn't any other option.

**ER:** The story you are telling is very similar to what's going on with agricultural pests.

**SP:** The issues are surprisingly parallel. Agricultural pests are treated with industrial-level insecticides just like the bacterial pests in our bodies are treated with industrial-level antibiotics.

**ER:** The numbers for pesticides used are astounding.

**SP:** Oh, it's just amazing. One hundred fifty million pounds of insecticides and 700 million pounds of pesticides are used in this country every year, and that generates a huge selection pressure on the pests to evolve resistance. We've been watching insects evolve resistance to pesticides for almost 100 years now. The first recorded case was in 1908 in California, and now well over 500 species of insects have evolved resistance to one or more pesticides; some of them have evolved resistance to multiple pesticides all at the same time.

There's an important economic cost to that: farmers spend an estimated 1.5 billion dollars to spray fields with either a different chemical because the first one didn't work, or to respray with the same chemical because the effectiveness of a particular insecticide is

waning as the population evolves resistance. So it costs money to fight off the resistant insects in these fields.

This also shows that biotechnology agents are not necessarily going to last forever, particularly the biotechnology where plants are engineered to make their own insecticides. Those engineering products are generating selection pressure on insects to evolve resistance to them, and it's not clear how long those biotechnology products are going to be effective in the field.

**ER:** I've heard estimates of eight to ten years before you have to engineer a new pesticide. It puts us in an arms race with the microbial world, or the insect world, in this case.

**SP:** Exactly. It is an arms race and it's the same kind of arms race we fight with bacteria and viruses. In the case of biotechnology, the inventions that we use to fuel our side of the arms race are quite a bit different, but the fundamental principal is that we've got to come up with something new in order to stay ahead of the game. As long as we can do that, some people will say, Well, at least we're still ahead of the game. But every time that arms race turns a cycle; that is, we invent something, the pest evolves resistance, we invent a new thing, it costs more and it drives the price of agriculture and health up and up.

At some point those costs get so high that the system collapses. There are well-known examples of agricultural fields that are simply unusable because with these huge infestations of resistant insects the cost of farming is higher than the crop is worth. The field just falls into disuse because the economics driven by evolution doesn't allow you to farm it any longer.

**ER:** Bioengineering of Bt sounds promising.

**SP:** It depends on whether you're talking about corn or cotton. Bt is engineered into both corn and cotton. The funny thing about the corn is that it's engineered to kill the European corn borer. We don't actually have the European corn borer in this country, except occasionally there are epidemics or plagues of it. So right now Bt is not all that useful in corn because the pest it's designed to attack has yet to be a problem.

However in cotton there are persistent and chronic pests that the Bt has been effective in reducing. The people who promote Bt say that they have used two million pounds less pesticide on the cotton crop every year because the cotton produces its own pesticide. I think most people would agree that that is an advantage.

But there are also signs of the evolution of resistance among the pests of cotton, so much so that the companies that make Bt plants now require farmers to plant part of their fields in plants that are not engineered to produce Bt. That's called refuge planting. The farmer is supposed to

**Evolution is not a theory, it's a fact. It does damage. We have to realize it so that we can understand how to combat it.**

give up about 4 percent of their field planted in cotton or corn that doesn't have the Bt pesticide engineered into it, and let insects eat their way through it. The idea is that you build up a big population of insects on your non-Bt crop, and that will dilute out the resistance that might be evolving in your Bt fields.

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The trouble, of course, is that farmers aren't stupid. They're going to follow the requirements to the letter and plant 4 percent of their fields in non-Bt crops, but they're going to plant the 4 percent of their fields that don't produce much. I've already heard of farmers planting gullies and all the little edges of their fields that they don't actually use much for crops anyway. They're planted with the non-Bt form of the crop because that's what they have to do, but they don't have to plant the best part of their field with it.

As a consequence the utility of the refuge planting is much less than theoretically it could be because it's a normal human reaction to say, If I've got to plant 4 percent of my field with this stuff that I'm not going to get anything out of, then I'm going to use the lousiest part of my field.

It's an interesting version of the

tragedy of the commons, because the common commodity here is the amount of time before the insects become resistant to this technology. That's something we're all interested in, but farmers are being asked to pay the price individually to make that time as long as possible for the rest of us.

**ER:** What is Bt?

**SP:** Bt toxin is a natural mix of compounds, and it's a slurry made of cultures of a bacterium called *Bacillus thuringiensis*. That slurry ends up being a white powder that includes bacteria and bacterial spores and a set of toxins that are collectively called Bt toxin. It's the world's bestselling biological pesticide and in its native form is restricted to killing caterpillars. When the Bt toxin protein gets into the caterpillar gut it disrupts digestion, making essentially the caterpillar just dissolve from inside once the caterpillar eats the stuff.

The biotechnology approach has been to take the gene for the Bt protein and insert it into the

DNA of the plants — corn and cotton for example — and have the plant make the protein-toxin on its own, then if an insect eats the plant it ingests this toxin and dies.

The Bt toxin slurry has been in commercial use since the late 1950s and only once or twice has any insect evolved resistance to it. But the reason that few insects have evolved resistance to it is that it isn't just a single toxin, it's a mixture of toxins and live bacteria and spores. When the gene is engineered into cotton or corn, a single gene is put into the plant, only lately have multiple genes been engineered

into those plants. It's much easier for insects to evolve resistance to a single gene than to the whole mixture of genes, so as a result many lab studies have shown that insects can easily evolve resistance to Bt-engineered corn or cotton because they are only using one of the potential Bt toxins.

**ER:** As little as one mutation can confer resistance.

**SP:** Exactly. Some of us have done a little thought game. We've said, Well, what would be the best way to teach an insect population how to evolve resistance to the whole Bt toxin slurry? If you wanted to do that, you would start by giving them one toxin and letting them evolve resistance to that. Then you'd give them two toxins, and then you'd give them three and then

**SP:** I have not seen any. My main worry about biotechnology is not that I think we've probably already done something awful but that it looks as if the industry is not well organized to think of all of the potential complexities.

One example is the scare that occurred about two years ago when a Cornell scientist reported that Monarch butterflies could be killed by the pollen made by Bt corn. Recently other studies have shown that it's not likely that that pollen would be dense enough in most situations to actually pose a danger to Monarch butterfly caterpillars in the wild, but the key point of that example is that a billion-dollar biotech industry never thought of that. They never tested it before planting millions of acres of corn. So even though that particular example might not turn out to be a big deal, it makes you wonder what else they haven't thought of.

My main concern is that you would like the consequences of these engineers to be well thought out by people for whom it's an advantage to think of the complexities rather than an advantage to dismiss the complexities.

The other thing is that I think it's pretty clear now that biological engineering is not the same as physical or chemical engineering. When you physically or chemically engineer something, you have a product that's fixed and static and you know what its properties are, whereas biological engineering is by definition engineering something into a malleable ecological setting.

If our corporate and scientific structures for engineering only allow us to do biological engineering in the same way we've done chemical and physical engineering, then we're going

**One hundred fifty million pounds of insecticides and 700 million pounds of pesticides are used in this country every year, and that generates a huge selection pressure on the pests to evolve resistance.**

four. Then when you give them four they'd probably be resistant to everything and then you'd be successful.

That is exactly what it seems like we're likely to do, but we don't want to be successful because success in this guise will mean the demise of the world's bestselling biological pesticide and one of the only pesticides that organic farmers can use. The organic farmers are worried that engineering Bt into crops will eventually cost them one of their major agricultural tools.

**ER:** What are the health effects of Bt?

to create many problems. We have to be able to think of biological engineering as different. I don't see that culture in biotech companies because they are essentially chemical companies that have gone into biotech.

**ER:** Whose responsibility is it to think about these things?

**SP:** Good question. One of the perfect examples of that is what's going on this minute with people all over the country trying to get a Cipro prescription. There is no regulatory agency that can step in and say, No, our national health policy is to not prescribe prophylactic antibiotics without any need. There's no regulatory agency that can do that, so as a result we are potentially creating a huge problem by distributing the drug that we may require in an emergency.

**ER:** That is, we could be developing Cipro-resistant anthrax?

**SP:** Absolutely. It's clear that Cipro resistance already has evolved. It's

common in gonorrhea bacteria, it's common in urinary tract infection bacteria. If you just look in the literature, you see it all over the place. So the genes for Cipro resistance are out there.

One of the tricky bits about bacteria is that they share genes. The genes for Cipro resistance can move from one bacterium into another, from a population that's out there now, into anthrax. The movement of genes from one bacterium to the next, usually takes place just between species that are similar to one another, but it sometimes

takes place across species. Also, bacteria are good at scrubbing the environment for genes that are floating around. So if a bacteria dies and falls apart and it has the genes for Cipro resistance, there's a chance that another bacteria growing in the same environment will pick up that gene and begin to use it. So these jumping genes mean that if we have a lot of people that take Cipro every time they get a pimple, then we'll build up this population of resistant bacteria, and then, God forbid, that person gets anthrax and if he takes Cipro, fine, but any movement of Cipro resistance genes into that infection means that Cipro's all of a sudden not going to be effective.

**ER:** How can we slow down evolution here?

drug therapy, the virus or the bacterium doesn't have any variation for ability to grow in that kind of massive drug cocktail. That removes the variation required for evolution.

Another way to fight back is to reduce the amount of selection that we generate. So, for example, if all we do to control pests in a field is to treat with a single chemical, then we'll get the evolution of resistance to that chemical as quickly as possible. But if we use other ways of reducing the insect population as well — baiting or trapping or releasing beneficial insects, predatory insects that eat them — then use chemicals just to clean up the small amount that's left, then we reduce the selection pressure on the population because we're using less chemicals. That's called integrated test management, and it's a good way of reducing the evolution of pesticide resistance.

**ER:** That is not a new idea.

**SP:** Not at all. But ironically, it's been invented over and over again for the same reasons. For example, IPM is now being practiced in hospitals.

Decades ago they would spray an operating room with antibiotics to disinfect it, and that's the best way to culture antibiotic-resistant bacteria in the operating room. Now they scrub it down, they use harsh chemicals to kill the bacteria in a different way than the antibiotics would. People are encouraged to wash their hands frequently, that's another way of reducing the spread of bacteria that's different than antibiotics.

Integrated pest management has been reinvented in hospitals and is one of the main shifts in hospital practice over the last decade not because they talked to farmers but because they

**My main worry about biotechnology is not that I think we've probably already done something awful, but that it looks as if the industry is not well organized to think of all the potential complexities.**

**SP:** If we go back to those three reasons why evolution happens, we can see that all we've got to do is knock out the pins from under one of them and evolution will stop or at least slow. We have good examples of knocking the pins out of all three of them in different circumstances to slow down evolution.

One of the best known tactics is drug overdoses, not drug abuse overdoses, but using large concentrations of drugs to overwhelm an infection and using multiple drugs to overwhelm it in different ways. That mechanism works because, like triple-



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stumbled onto it by trial and error because they had a serious evolutionary problem.

**ER:** Why is it so difficult to get this information across to people?

**SP:** Part of the reason why there hasn't been enough communication is because the root of the problem has never been named. The root of the problem is evolution, and we persist in tiptoeing around whether evolution is a theory or a fact. It's not a theory; it's a fact. It does damage. We have to realize it so that we can understand how to combat it. Once we understand that we're fighting the evolutionary process in an agricultural field or in a hospital, then we can begin to address it instead of saying, Well, we've got to use mouse traps over here, and I don't know what we're going to do over there.

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