to grow at a great rate. Our societies haven't imploded yet only because most of the world lives at a level of privation Westerners would not accept, beyond the reach of the very resources Westerners cannot live without.

And therein lies the dilemma. To the extent that Westerners support development in, and extension of their prosperity to, the rest of the world, they sow the seeds of everyone's destruction. As McMichael stresses, there may already be too many people in the world to support universal living standards at a level Westerners consider minimal. There isn't enough land, enough water, or enough resources. In a zero sum game, reality trumps altruism; the price of comfort for some being the misery of others. Reading *Human Frontiers* after the September 11 attacks was a particularly eerie experience: the horrible pictures on television somehow seemed a logical consequence of the book's complex ecological truths.

What to do? McMichael doesn't say. But *Human Frontiers* makes a strong if understated case for broader thinking and broader planning, for getting and hanging onto "the big picture." He takes no position on Francis Bacon's view that the dream of every thinker is to replace the politician by the scientist. Probably aware that kings and statesmen once agreed with that proposition, McMichael instead allows the modern reader to discover the need for just such an infusion of science and ecological thinking into public policy-making. Are such changes possible when so many distrust science and associate "ecology" with nerdiness and political agendas? Perhaps at this point it is helpful merely to voice alarm, in the hope that scientists and policy-makers will find new ways to realize Bacon's 400-year-old dream.

BOOKS: GENETICS

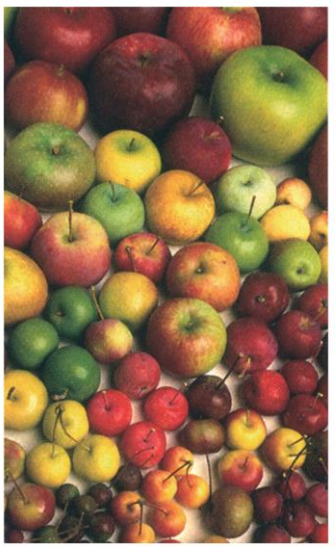
Also Sprach *Homo mutans*

Norman A. Johnson

At the beginning of Stanley Kubrick's film *2001: A Space Odyssey*, an extraterrestrial monolith implants in ape-like animals increased intelligence and the ability to make bone weapons. With this skill, our ancestors defeat their enemies. In reality, however, *Homo sapiens* is the monolith. The fictional monolith perturbed hominid evolution, but it is our species that has deliberately influenced the evolutionary paths of countless others. Our "one preeminent trait," according to writer and essayist Sue Hubbell, is "our ability to modify the world to make it nice for ourselves." In *Shrinking the Cat*, she explores the means and consequences of our shaping animals and plants for our own use.

Hubbell presents four case examples of domestications we humans, whom she calls "*Homo mutans*," have performed: corn, silkworm moths, cats, and apples. As her title suggests, in the course of domesticating cats, humans have shrunk them. Not only have we reduced the size of their bodies, we have also disproportionately shrunk their brains; house cats have only about 70% of the neurons that wildcats have. In addition, their adrenal glands, which are involved in the production of "fight or flight" hormones, are smaller. We are thus left with a more docile animal.

As much as we have altered the cat, we have altered other creatures even more. Hubbell asks us to consider the following thought experiment: Suppose humans were to completely leave Earth (perhaps, as she suggests, due to an invasion by "little green men"). What would eventually happen to the species we *Homo mutans* have altered? The success of feral cats suggests that domesticated cats may be able to survive without humans. Would the silkworm moth, *Bombyx mori*? In the process of shaping it into a silk-producing machine, we have made it larger and more docile than its wild counterpart, *B. mandarina*, and unable to fly. The domesticated moths lack the foraging skills of their ancestors. "They simply wait patiently to be given food by a human hand, and they placidly die if it is not forthcoming." These creatures of our designing would soon perish without our care. So would the apple (a cross between disparate ancestors, usually raised by grafting) and corn (many varieties of which are sterile hybrids).



Not simply red. A small sample of the existing variety in apples.

In the course of describing how we domesticated these species, Hubbell also tells stories about our history and culture. She discusses, for instance, how various governments, from ancient China to pre–Civil War United States, have encouraged their populaces to raise silkworms—with varying degrees of success. We also learn the true story of "Johnny Appleseed" as well as how the silk roads led to the spread of both apples and the plague.

In the film *2001*, the bone that goes flying up into the sky becomes a spaceship orbiting Earth, suggesting no fundamental difference between bone tools and spaceships. Likewise, Hubbell states that there is no fundamental difference between our thousands of years of domestication and our scant-decades-old practice of genetic engineering. She argues that we have engineered the genes of countless species long before we knew of genes. But as science writer Colin Tudge (*1*) and many others have pointed out, there is a profound difference between traditional breeding and genetic engineering. In the past, we modified organisms, but the range of genetic variants we could choose from was strictly limited to what already existed within the species (or possibly, closely related species) or what could appear via mutation. Now, we can grab a gene from a mammal and put it in a plant. This is an important difference, one minimized by Hubbell.

Shrinking the Cat
Genetic Engineering Before We Knew About Genes
by Sue Hubbell
Houghton Mifflin, Boston, 2001. 191 pp. $25. ISBN 0-618-04027-7.

We need to be mindful of the novelties as we decide how to use the new technique. We also need to be mindful that the advantages of genetic engineering are not limited to the pocketbooks of "big pharm." Indeed, environmentalists should support responsible uses of biotechnology. After all, as Hubbell reminds us, genetically engineered bio-control was developed as a more environmentally friendly alternative to pesticide use.

Hubbell believes that part of the controversy over genetically modified organisms arises because "biologists haven't done a very good job of explaining their research in terms that non-scientists can comprehend." I agree and commend her for trying to bridge the gap. Hubbell's narrative and her short, user-friendly guide for further reading offer an excellent starting point for exploring how we humans have deliberately modified organisms throughout our history.

Reference
1. C. Tudge, *The Impact of the Gene* (Hill and Wang, New York, 2001).

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