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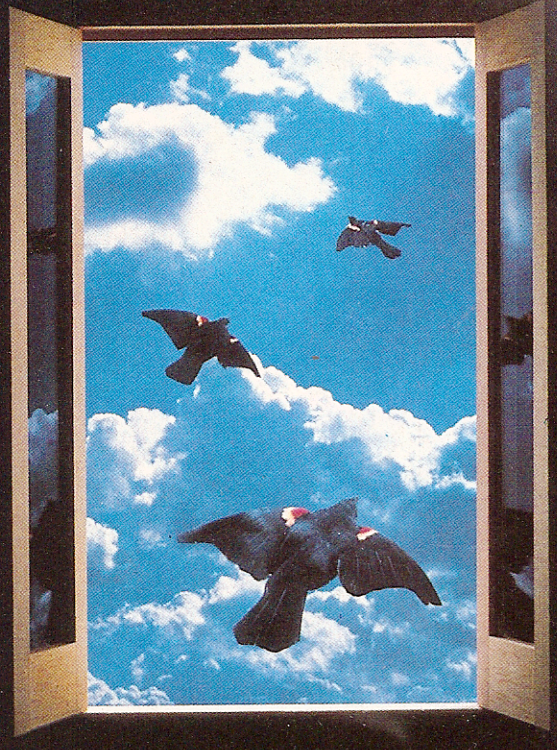

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WHY WE HAVE SEX

LIFE

By Kathleen McAuliffe

Sex is something of an embarrassment to evolutionary biologists. Textbooks understandably skirt the issue, keeping it a closely guarded secret. But honest scholars will admit openly—at least when cornered—that they are genuinely baffled by the widespread popularity of this activity in nature. Their confusion comes down to this: Whereas every asexual reproducer can generate offspring, only half the population of sexual reproducers—the females—are capable of bearing young. By all rights simple cloning should be a much more efficient method of disseminating one's genes (though if it's any consolation, it would not appear to be nearly as much fun).

Traditionally biologists have insisted that sex is beneficial to survival because it generates diversity. It is a simple matter of common sense that a species whose members are varied should be better equipped to meet the next catastrophe. But as latter-day evolutionary theorists have demonstrated mathematically, this bonus is negligible compared with the overwhelming numerical advantage of asexual proliferation. Indeed, disenchantment with the variability hypothesis led George Williams to concede in the last paragraph of his classic book *Sex and Evolution*: "I am sure that many readers have already concluded that I really do not understand the role of sex in . . . evolution."

The problem is so perplexing that two respected biologists recently proposed viewing sex *not* as an adaptation but "as a form of disease that animals and plants learn to live with." Michael Rose and W. Ford Doolittle, of Dalhousie University, in Halifax, Nova Scotia, note that certain genes found inside bacteria cause them to sprout phallic projections, which they thrust into neighboring cells. The genes then escape through these protrusions to infect new bacterial targets. Such "parasitic DNA sequences," the scientists theorize, may have brought about the first primitive form of copulation early in the evolution of life, starting an epidemic that spread throughout nature.

By this stage creationism may be starting to look like an attractive alternative to evolutionary theory. Surely there must be a more plausible—not to mention aesthetic—explanation for why sex evolved than the parasitic-DNA theory can provide. Has some crucial function of sex been overlooked?

Microbiologists Harris and Carol Bernstein think so—and a sizable body of evidence backs them up. A husband-wife research team at the University of Arizona, in Tucson, they did not set out to solve this evolutionary conundrum. Rather they were interested in studying the causes of aging. But in their quest to understand what triggers our decline, they also may have uncovered the secret to rejuvenation.

In the mid-Seventies, the biologists noticed a number of research reports that showed how damage accumulates in the DNA of cells as they grow older. Fortunately, minor deterioration gets repaired over the course of normal cellular growth by special enzymes, or chemical tools, that "snip" out the damage and then "glue" the molecule back together again. This is possible because two complementary strands of genes make up DNA's double-helical structure: Enzymes repair a nick on one chain, for example, by modeling it after the pattern on the duplicate chain. But heavy-duty damage, such as a breakage at the exact same location on both strands of the double helix, cannot be fixed; it builds up over a lifetime. Could such genetic erosion, the Bernsteins wondered, be the hidden cause of senescence and, ultimately, death?

A review of the literature strengthened their conviction. In several studies animals subjected to agents known to harm DNA were found to suffer from such signs of accelerated aging as premature graying and menopause. Still other researchers have uncovered evidence suggesting that the efficiency of a species' DNA-repair system determines the upper limits of life span. Summing up these findings, Carol reports that "the level of DNA-repair capacity correlates with life span in twenty-one

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Sex may have evolved as an internal first-aid kit to repair damaged DNA and keep babies young.

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mammalian species, from shrew to man."

If genetic damage is in fact the cause of aging, then this presents still another problem: By the time an organism reaches the age of procreation, the DNA in its germ cells—eggs and sperm—would presumably have accumulated a considerable amount of wear and tear. This would imply that each new generation should be born older than the next. Carol, then pregnant with her third child, found herself pondering: "Why are babies born young?"

Enter sex.

To produce eggs and sperm, the sex cells in the body undergo a special type of division known as meiosis. Prior to fertilization the chromosomes inside this type of cell perform what amounts to a highly ritualized mating dance. In perfect synchrony they move to embrace each other intimately, coming together in complementary pairs (each consisting of chromosomes inherited from paternal and maternal lineages). Thus entwined, the partners begin a molecular square dance. They perform do-si-dos with each other, swapping bits and pieces of chromosomes in a process known as recombination. As the dance comes to a close the partners split apart, never to meet again. Each chromosome will remain a single strand until united with a new mate, when egg and sperm fuse at conception.

Fascinated by this elaborate procreation rite, the Bernsteins began to wonder whether it might explain how germ cells maintain their vitality. To pursue this hunch, they started experimenting with bacteria and viruses—organisms that have not yet evolved meiosis but nonetheless engage in a rudimentary form of sex involving recombination. From hundreds of tests, they concluded that recombination is a highly efficient DNA-repair mechanism, capable of reversing the genetic deterioration of a lifetime in a single stroke. Unlike the simple "cut-and-paste" procedure that occurs during normal cellular repair, recombination is more akin to transplantation surgery. By grafting DNA from one chromosome to the damaged site on its complementary partner, the process can mend even the most severe tears and breaks in the hereditary molecule.

Far from being a disease, sex would appear to be nature's method of "tuning up" our DNA, thereby bringing about the miraculous rejuvenation of life. In a cell undergoing meiosis it is unlikely that the set of DNA from the mother will suffer identical damage as DNA inherited from the father. Thus, one parental set of genes serves as a "correction key" against which errors in the other set can be checked. If this process had not evolved, argue the Bernsteins, offspring would inherit worn-out DNA. Or, as Carol observes, "Babies would be born old." ∞