The essence of evolution is related to the creative process. The availability of platinum is said to pose problems for the mass use of fuel cells. The reintroduction of species to central areas of their historical range is advocated. A British national register of children conceived with the use of intracytoplasmic sperm injection is announced: "[I]t is important to establish epidemiological systems to monitor...offspring so that in the future, potential parents may [have] an understanding of the magnitude of any risks...." And a correction to a report on the selective advantage of low relatedness is made.

The Force of Natural Selection

Jacob Goldenberg *et al.* ("Creative sparks," Essays on Science and Society, *Science*'s Compass, 3 Sept., p. 1495) discuss the nature of creativity. They dispel the notion that total freedom is necessary for the creative process. The authors state that while randomness is of value, a structured process is the key to creativity. I agree with their assessment, but would like to suggest that this is the very essence of the evolution of life. Life is a structured process that evolves through accumulation of random (although limited) mutations. It is subject to judgment by the force of natural selection rather than a panel of experts. The products of this creative process are all the myriad forms of life, past and present. Consistent with the authors' idea that regularities can serve as an infrastructure for generating creative ideas, most life forms are built up from some regular plan or framework (for example, radial symmetry in echinoderms). The authors conclude that we must reappraise our fundamental approaches to creativity. Perhaps we can learn something about creative processes by studying evolution.

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Fuel Cells and Precious-Metal Catalysts

The news article by Robert F. Service about fuel cells ("Energy," 30 July, p. 682) does not address an important problem associated with their mass use.

Fuel cells require precious-metal (usually platinum) catalysts to operate at reasonable temperatures. But how much platinum—in great demand as an industrial catalyst—would be required for a world fleet of fuel cell–powered cars? Platinum has a crustal abundance of only 37 parts per billion (*1*), and total annual production of virgin platinum is less than 100 metric tons (*2*). If each fuel cell–powered car required only a gram of platinum (which, I think, is a low estimate), it would take 200 metric tons of platinum to power the U.S. fleet of cars alone.

Although platinum can be recycled, world-scale fuel cell production for automotive and home use would probably require more than the entire annual production of virgin platinum. Because this metal is also an important industrial catalyst, demand would send the price of platinum through the roof. This would destroy any cost savings obtained from mass production of fuel cells and bring us right back where we are now—with fuel cells that are too expensive to be competitive in the mass market.

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Lynx Reintroduction

The News Focus article by Keith Kloor about the reintroduction of lynx to Colorado (16 July, p. 320) raises several questions regarding efforts to reestablish extirpated populations of imperiled species. Reintroduction of species as part of a well-coordinated effort to recover species to their historical range has proven effective for a number of species in recent years. Several factors affect the results of species introductions. First, efforts to reintroduce mammals seem to have been more successful than efforts with other taxonomic groups. Other factors that contribute to the success of reintroduction include the release of animals into high-quality habitat and the use of animals from increasing populations (*1*). Two of these conditions were met in the ongoing effort to reintroduce lynx to Colorado. However, the absence of high-quality habitat and a reintroduction area that was at the periphery of or outside the historical range are factors that are negatively correlated with reintroduction success (*2*). In the case of the lynx, their historical range in Colorado is at the southern periphery of the species range and is isolated from other lynx populations.

Others have had difficulties establishing species in the periphery of their historical range (*3*). The difficulties encountered in Colorado, the marginal success of the reintroduction of the woodland caribou in northern Idaho and elsewhere (*3*), and the failed or marginal success of the reintroduction of the sea otter in Oregon and California (*4*) share two features: the species were reintroduced on the southern edge of their historical range, and reintroduction was during a period of putative climate warming (*5*). Historical range limits were generally delineated before the current warming, and we would expect warming to shift the southern boundaries of the acceptable climatic conditions northward, or upward in elevation, especially for northern species (*6*).

One of a few dozen Canadian lynx that are being relocated in Colorado.

Intensive monitoring of the fate of the remaining lynx in Colorado may offer significant insights into current limiting factors for this species. However, continued habitat degradation and strong anthropogenic factors such as vehicular traffic, resource extraction, and recreational activities in Colorado may contribute to the low likelihood of reestablishing the lynx at the fringe of its original habitat. Thus, it seems logical that attempts to augment lynx populations in more central areas of their habitat range, where populations have fewer pressures, better habitat, and access to other lynx populations, would perhaps be more advantageous for the species (*7*).

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Intracytoplasmic Sperm Injection

The imaginative essay "Sex in an age of mechanical reproduction" by Carl Djerassi (Essays on Science and Society, *Science*'s Compass, 2 July, p. 53), which includes an excerpt from his stage play *An Immaculate Misconception*, identifies a number of important broad ethical and social issues relating to the use of intracytoplasmic sperm injection (ICSI) that need wider appreciation and discussion. One hopes that his play may help expedite this process.

One question of great practical importance to those considering an attempt to conceive using ICSI technology and to those who already have offspring conceived in this way is whether offspring conceived by ICSI have an increased risk of any serious adverse health outcome. There are at least three theoretical concerns relating to the health of ICSI offspring. First, what is the extent of heritable conditions among offspring that were inherited from an affected parent, but which may have rendered that parent infertile before the introduction of ICSI (*1, 2*)? Second, what are the possible consequences of ICSI itself, which is a relatively invasive and traumatic procedure involving potentially toxic chemical baths (*2, 3*)? Third, what are the possible adverse consequences of using sperm that in many cases would not have been fit or mature enough to achieve fertilization before the introduction of ICSI (*4*)?

The risk of a number of adverse outcomes, ranging from still births, birth defects, and cancer to pediatric developmental delay, might be increased among ICSI offspring. More ICSI offspring must be studied before we can satisfactorily address the question of a birth defect excess. Consider a condition that normally affects 2% of births. To detect a doubling in the level of risk (with the use of a 5% one-tailed test of significance) and to ensure an 80% chance of detecting this risk, one would need to study 1000 ICSI offspring and 1000 control offspring. For a condition that normally affects 1 in 1000 births, the corresponding number of offspring that would need to be studied would be 20,000 in each group.

One of the largest series studied to date included 423 ICSI offspring (*5*), and the data were the subject of a detailed independent review (*6*). As a result of different definitions and methods of ascertainment of birth defects (*4*), the original investigators interpreted the data as providing reassurance (*5*), whereas the independent review investigators identified grounds for concern (*6*). The original investigators expanded their series to 877 offspring (*7*), but because they used a study methodology similar to that used in their first study (*5*), the conclusions are subject to the same questions. Large numbers of offspring would also be necessary to detect an increased risk of cancer (*8*). Finally, two recent articles and an accompanying editorial (*9*) have assessed the possible consequences of ICSI on mental and psychomotor development in the initial years of life, and further large-scale follow-up of ICSI offspring has been strongly advocated.

With such uncertainty, it is important to establish epidemiological systems to monitor these offspring so that in the future, potential parents may make the decision to opt for ICSI in an informed way—with an understanding of the magnitude of any risks for potential offspring to balance against the obvious benefits for the parents. Toward this objective, we are establishing in the United Kingdom, with the support and guidance of an expert advisory group, a national register of offspring conceived with the use of ICSI. We recognize that this is an area in which international collaboration is likely to be necessary to satisfactorily investigate whether some rare adverse outcomes occur in excess among ICSI offspring.

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