

Darwin Initiative
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Our Choice: How Many Species Will Survive the 21st Century

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The Darwin Initiative is a brilliant concept that was conceived in connection with the Earth Summit in Rio de Janeiro in 1992. For more than a decade it has made possible effective contributions by many people and organizations in the cause of biodiversity conservation in countries around the world. All those associated with the Initiative should be justifiably proud of what has been accomplished through the projects themselves, the scholarships, and the high level of cooperation between biodiversity scientists throughout the world in supporting one another to preserve plants, animals, fungi, and the ecosystems that they inhabit. Serious problems have been solved, and arrangements have been put in place that clearly will be of lasting value for future generations.

Yet as we pursue the preservation of biodiversity, we need to keep in mind the relationships expressed in ringing words of India's Prime Minister Indira Gandhi at the United Nations Conference on the Human Environment in Stockholm in 1972. Mrs. Gandhi stated, "The inherent conflict is not between conservation and development but between environment and the reckless exploitation of man and the earth in the name of efficiency." Ultimately, biodiversity can be preserved only in a sustainable world; it is not something that exists and can be addressed independently. Unless we continue to move strongly towards the goal of comprehensive sustainability for the world as a whole, the relentless pressures of population growth, of our ever-increasing affluence (consumption), and of our use of inappropriate technology will certainly condemn our descendants to living in a monotonous world, much more uniform than the one we enjoy today, and very much poorer in the biodiversity that makes human life possible. The challenge of attaining a sustainable world includes maintaining our rich biological and cultural heritage, a heritage that underpins the healthy, peaceful, and prosperous lives that we desire for all people. The objectives involved in attaining sustainability have been well posed by Kai Lee (1993, p. 200), who wrote as follows:

"How much misery will it take to make a global norm of sustainability first visible, then credible, then feasible, then inevitable? We do not know. And we do not know if the lessons of environmental disaster can be learned in time to ward off still more suffering. However bleak that prospect, we in the rich nations must bear the certain knowledge that our societies are both historically responsible for many of the circumstances that imprison the poor and that we will on average fare much better than they. Against this background it is possible to see that sustainable development is not a goal, not a condition likely to be attained on earth, as we know it. Rather, it is more like freedom or justice, a direction in which we must strive, along which we search for a life good enough to warrant our comforts."

How closely are we approaching this ideal, and what do our activities mean, in a practical sense, to the survival of biodiversity? To provide a context for our considerations, we

need to examine history as a basis for understanding the present and predicting the future.

The planet Earth is approximately 4.5 billion years old, with living cells appearing no less than 3.8 billion years ago and photosynthesis -- the process by which living organisms capture a small fraction of energy of sunlight and transform it into the chemical energy that they use to power their own life processes as well as the life processes of the organisms that consume them -- evolving a few hundred million years later. The first photosynthetic organisms were bacteria, specifically cyanobacteria, and the masses of these organisms that flourished in ancient seas gradually transformed the earth's atmosphere from a reducing one to the oxidizing one we have today. About a fifth of our atmosphere consists of oxygen molecules (O₂), in equilibrium with a small amount of ozone (O₃) that, in the stratosphere, protects our planet from the bombardment of ultraviolet-B radiation, so destructive to the large molecules of living organisms. In addition, masses of cyanobacteria, falling to the seafloor over billions of years and subsequently buried, became the rich deposits of petroleum and natural gas that have powered the modern world for more than a century.

It was not until approximately 440 million years ago, however, that organisms first began to inhabit the surface of the land: all earlier life had existed in water, or beneath the surface of the soil. Within a short space of geological time, the ancestors of vertebrate animals, arthropods (insects and their relatives), land plants, and fungi moved onto land, perhaps because by that time, 90 percent of the way through the history of the earth, the growing ozone layer afforded enough protection to allow them direct exposure to the sun's rays. These terrestrial organisms diversified rapidly in the more sharply defined habitats on land and soon outnumbered in species, if not in their overall diversity, the marine relatives that they had left behind. When masses of vegetation had formed in the swamps and forests, their dead remains were slowly converted to coal deposits, the third major source of fossil fuel that we exploit in our modern industrial society.

The collision of a massive meteorite, or asteroid, with our planet approximately 65 million years ago threw up a thick, persistent cloud that, perhaps by interfering with the process of photosynthesis on a global scale, brought about, directly or indirectly, the loss of an estimated two-thirds of the species of terrestrial organisms that existed earlier. The last dinosaurs disappeared, and the character of modern groups such as birds, mammals, and reptiles changed with the ascendancy of some lines, the loss of others. Following this disaster, there was a period of perhaps 10 million years during which a gradual recovery took place over a period incalculably long in human terms. Then species numbers began to grow to the levels that exist now, almost certainly the highest numbers of species that have ever existed at one time.

In the modern world, there are perhaps 10 million species of eukaryotic organisms (May, 1997, estimated 5 to 13 million), of which, however, only about 1.5 million have been recognized and named scientifically. Attempts to estimate the numbers of species of prokaryotic organisms, bacteria, archaeobacteria, and their relatives, or viruses, are absurd: we simply do not have enough information to do so meaningfully. Even for eukaryotic organisms, we know no more than one in six of the species that exist, and possibly a much smaller proportion. We are uncertain whether there are 250,000 or 350,000 validly named species of vascular plants, and have no accessible index that will guide us to the answer; many thousands more await discovery. Groups such as fungi,

nematodes, and mites are so poorly known that we cannot even describe their patterns of geographical distribution accurately. It is for these reasons that conservation activities need to be securely based on sound science, and why conservation-oriented actions alone, however desirable they may be, will in general be unlikely to achieve lasting conservation outcomes.

Changing conditions over this substantial period of time, eventually giving rise to today's highly varied regional climates, clearly accelerated both the growth in species number and the increasingly local nature of their distributions. Thus the continental glaciation that began to spread over Antarctica 13-18 million years ago steepened the gradient of temperatures from equator to the poles. As modern biological communities began to replace the widespread subtropical to warm temperate forests of the past, scrublands, grasslands, true tropical rainforests, polar tundras, and deserts spread, sometimes rapidly, and organisms became increasingly diverse.

Into this rich and diverse biological setting human beings, genus *Homo*, appeared, evolving gradually from their ancestors in the genus *Australopithecus*, about two million years ago in Africa. Diversifying, they discovered the uses of fire, of increasingly sophisticated tools, of the beginnings of art, and of language. As they migrated from Africa to Eurasia, then to Australia, to the Americas, and ultimately to almost all of the world's islands, they progressively caused the extinction of many kinds of large mammals, birds, and reptiles. Despite this, the hunter-gatherer populations that comprised the whole human race for most of our history clearly had a relatively limited impact on the world as a whole. Their numbers were always low. Thus, 10,000 years ago, a mere 400 human generations, the entire human population consisted of an estimated several million people, about 5 percent of that of modern Britain. These people were spread very thinly over much of the surface of the globe, at about the density of the native peoples of Australia before European settlement commenced there. But an event that would radically change our relationship with the rest of the world was about to occur.

That event was the domestication of various wild plants as crops. It took place in a number of different regions, in the Fertile Crescent at the eastern end of the Mediterranean, in China, in India, in eastern Europe, in Mexico and Peru, and elsewhere, over a long period from about 10,200 to about 5,000 years ago. Once domesticated, these plants provided wealth to those who grew them and, by possessing their grains and other products, were able to cope much better with unfavorable seasons than had been possible earlier. As a result, our relationship with the rest of the world was about to change profoundly. Human numbers increased rapidly, as villages, towns, cities, and eventually states were organized. Wars were waged for the stored food, the arable land on which it could be produced, or the other forms of wealth that it symbolized. In their growing settlements, people began specializing to take up various occupations, so that poets and story tellers, weapon makers and builders, religious and political leaders, artists, and individual careers were formed. Collectively, these actions came to constitute the rich strands of our civilization -- a set of practices and beliefs that embodies what we value most highly about ourselves and our fellow human beings.

Human populations began to swell, given their expanding sources of food, so that there were several hundred million people on earth by the time of Christ, and perhaps twice that many by Renaissance times. When the Reverend Thomas Malthus, in the 1790s, made his famous prediction that human population growth would outstrip food production, so

that there would be widespread famine in the future, the human population amounted to some 850 million. Malthus' predictions proved wrong because he failed to appreciate the growing power of the Industrial Revolution, just gathering speed at the time he was offering his views on the future, even though human . By the time of the Napoleonic Wars, there were a billion people for the first time, doubling in just over a century (4-5 generations) to two billion people. In 1950, there were approximately 2.5 billion people, and in the following half century, over the course of just two generations, our numbers swelled to 6 billion people, and now to approximately 6.2 billion, an unprecedented number exploiting the earth as an ecological dominant without precedent.

During the second half of the 20th century, in a period of only 50 years, the activities of human beings caused a number of drastic changes in the Earth's sustainable systems. Among them were the following: the loss of about a fifth of the topsoil that existed in 1950; destroyed the productivity of approximately a fifth of the arable land that existed then, through over-fertilization, desertification, urban sprawl, and other malign activities; cut about a third of the world's forests without replacing them; added about a sixth to the amount of carbon dioxide, the principal anthropogenic cause of global warming, in the atmosphere; and depleted the stratospheric ozone layer by approximately 6-8 percent. Worst of all, we are driving species of plants, animals, fungi, and microorganisms to extinction about a thousand times faster than one would expect. In short, we are using the earth's productive systems at an unsustainable rate, one that we cannot really afford -- a rate that will inevitably make our planet less diverse, less healthy, less beautiful, and with fewer possibilities for the future development of sound, sustainable systems than we have now.

With respect to biological extinction, we are able to estimate the global rate by comparing species longevity in the fossil record, an average of one species per million per year becoming extinct, with the observed extinction rates over the past few centuries for well known groups such as vascular plants, butterflies, and vertebrate animals. For example, over the course of the past thousand years in the Pacific, the period of Polynesian and later European colonization, at least 1,000 species of birds, approximately a tenth of the world's total, have disappeared forever. With the estimated destruction of perhaps 95% of the world's tropical moist forests over the course of the 21st century, it is projected that as many as two of every three species that exists now may disappear permanently, or be reduced to populations too small for long-term survival, before the dawn of the 22nd century (reviews in Pimm and Brooks, 1999; Dirzo and Raven, 2003).

Striking is the fact that we are likely never to have seen, or to be aware of, the existence of most of the species we are driving to extinction. In tropical moist forest, we have catalogued so far probably fewer than one in twenty of the species present -- which is one reason that the losses are so tragic. Against this background, the efforts of the House of Lords (2002) to encourage the growth of systematics nationally and throughout the world provide a sound basis for action. Not only is a sound base in systematics necessary to carry out conservation activities responsibly, it is also necessary in a world that will increasingly depend on biological information for sound, sustainable economic progress.

The loss of these species clearly will have a negative impact effects on future human prospects. We derive all of our food; most of our medicines; a major proportion of our building materials, clothing, chemical feedstocks; and other useful products from the living world. In addition, the communities and ecosystems that it comprises protect our

watersheds, stabilize our soils, determine our climates, provide the insects that pollinate our crops (Baskin, 1977; Daily, 1977). Early in the age of molecular discovery, living organisms hold much of the promise for the development of currently unknown sustainable systems in the future. We are, however, losing the diversity of organisms at an unprecedented rate just as we are starting to appreciate it, and while knowing only a small fraction of the species that exist. And finally they are simply beautiful, enriching our lives in many ways and inspiring us every day. By any moral or ethical standard, we simply do not have the right to destroy them, and yet we are doing it savagely, relentlessly, and at a rapidly increasing rate, every day.

What can we do to turn back the tide? To suppose that we can save species in isolation from the great currents that are flowing throughout the world and changing its structure profoundly is to put ourselves in the position of King Cnut. We can turn our attention to hotspots, areas in which a great deal of biodiversity is concentrated in relatively small areas. With colleagues, Norman Myers (Myers et al., 2000) calculated that nearly half of the world's plant species, 30% of the birds and mammals, 40% of the reptiles, and more than 50% of the amphibians dwell within 25 areas of extraordinarily concentrated biodiversity, which Myers had earlier named "hot spots." These areas together cover about 17 million square kilometers, but only about 2 million hectares within them still retain their original vegetation. By concentrating on the "hot spots," or generally on the tropics, where more than half of the world's species exist, we could certainly save more species that we could with a less focused approach. But will we actually do so?

Consider the condition of the world at the present day. Most people live in a state of relative optimism, believing that the world is steadily getting better. In terms of the use of resources, this feeling has been bolstered by the 1987 report of the World Commission on Environment and Development, "Our Common Future," subsequently adopted by the U.N. General Assembly. This report calls for sustainable development, defined as "development which meets the needs of the present without compromising the ability of future generations to meet their own needs." In other words, it combines the need to protect natural resources with the improvement of living standards: ecological systems and human systems working in harmony with one another. Despite the strong emphasis given this area in the recommendations of the Earth Summit at Rio de Janeiro (Sitarz, 1993), however, relatively little progress has been made. Why has this been so?

Despite Indira Gandhi's clear call for action in 1972, the disparities between people have continued to grow rapidly. At the 1992 Earth Summit, which like its predecessor 20 years earlier was organized under the tireless and effective leadership of Maurice Strong, these themes were re-emphasized and expanded, but industrialized nations did not, by and large, rise to the challenge. What the meeting did bring into sharp focus, however, was the huge difference between the concerns of the governments of industrialized countries, a fifth of the world's population with a per capita income of more than \$22,000 and a life expectancy of 76 years, with those of the developing countries, four-fifths of the world's people, with a per capita income averaging about \$3,600 and a life expectancy of 65 years. Some 1.3 billion people live in acute poverty, with incomes of less than \$1 per day, 840 million of them receiving less than 80 percent of the U.N.-recommended minimum caloric intake, and thus literally starving. Indeed, by WHO standards, half of the people in the world are malnourished in some respect.

Against this background, is it practical to imagine the worldwide sustainable utopia envisioned in the Brundtland report? Only through the development of new ways of thinking and acting could this be accomplished. Thus Wackernagel and Rees (1995) have emphasized again that if everyone lived at the standard of industrialized countries, it would take two additional planets comparable to Earth to support them, three more if the population should double; and that if worldwide standards of living should double over the next 40 years, twelve additional "Earths." Aspirations to such a standard of living are clearly unattainable, and yet our advertising industry continually tells everyone that it is not only appropriate but also achievable. Even those who already live in rich countries continually strive to seek to improve their standards of living, joined by increasing numbers of newly affluent consumers from developing countries (Myers and Kent, 2003). The paradox presented by these relationships can be solved only by achieving a stable population, finding a sustainable level of consumption globally, accepting social justice as the norm for global development, and developing improved technologies and practices to make sustainable development possible. As Kai Lee emphasized, we must search for a life good enough to warrant our comforts. But shall we do so?

We certainly understand better than ever the nature of the problems confronting us, but our willingness to deal with them, as we enter the new millennium, remains limited, whether they be global warming, the destruction of forests, toxic pollution, the control of nuclear arms, or the destruction of the biological diversity on which we so confidently hope to base so much of our future prosperity. More than a decade after the Earth Summit, industrialized nations have by and large not funded the important recommendations of Agenda 21, the principal document that emerged from the meeting, and if anything seem less interested in taking those recommendations seriously as time goes by.

Notwithstanding this inertia, the whole modern world is profoundly interconnected regardless of whether we recognize that fact. If we truly would like those who come after us expect to enjoy the benefits of a peaceful, healthy, and prosperous world in the twenty-first century and beyond, we clearly will need to find new ways of thinking and new ways of acting. The mores of our hunter-gatherer ancestors, who foraged over the surface of the world 400 generations ago, are wholly insufficient to meet the challenges of the modern world. Four-fifths of the world's people share the benefits of only 15 percent of the world's economy. Their countries are home to less than a tenth of the world's scientists and engineers. As long as these relationships are sustained, there can be no hope for global sustainability, and only limited prospects for the conservation of biodiversity. In fact, the global system can operate properly only if there are increased financial contributions from the North, and a common will to make mutually beneficial changes in our modes of operation and in our common expectations for the future. Among the goals that we must strive to attain are a stable population, a sustainable level of consumption, and the development of new technologies much less destructive than those employed currently.

Over the course of the twentieth century, it has become apparent that humanity cannot expect a healthy, peaceful, and productive future -- a sustainable one -- if we continue to use or waste nearly half of the total terrestrial photosynthetic productivity, to appropriate more than half of the available fresh water for human use, to continue to alter the characteristics of the atmosphere rapidly, and to drive species, their genetic diversity, and the communities and ecosystems in which they live, to extinction in such large and rapidly growing numbers. Food security, health, and social justice -- the ability of each human

beings to be able to express his or her unique potential -- all of these desirable outcomes depend on our ability to rise above our parochial and perhaps ingrained views of how to live, and to learn together how to manage our planetary home for our common benefit. Empowering women throughout the world, seeking means to raise their status, and alleviating their poverty are among the most important efforts to be undertaken if we are to achieve global sustainability. Science and technology are necessary tools in this struggle, but they are not in themselves sufficient. Corporations and individuals must join governments in working towards a better world in the future, but the decisions that will ultimately control the shape of that world will be moral and individual. Nothing less than a new industrial revolution (Hawken, Lovins, and Lovins, 1999) and a new agriculture (Conway, 1997) are required to make possible the sustainable world of the future.

Clearly, saving as many species of organisms as possible is one of the most valuable contributions that we can make in providing for our common future. As Ed Wilson has pointed out so cogently, the failure to do so is likely to be the crime for which our descendants are least likely to forgive us. Against this background, the work made possible by the Darwin Initiative that we are celebrating here is a concrete effort to stem the tide, with an impressive record of returns far exceeding the level of funds provided, and a reasonable expectation of even greater progress in the future. By building the knowledge base on which alone sound conservation practices can be based, by empowering people throughout the world to take their future into their own hands, by sharing and by caring enough about one another. It is in effect one of many concrete steps that must be taken to achieve sustainability.

Such a valuable initiative can be used as the basis for further growth in our ability, for example, to increase the proportion of the tropics in preserved areas from its estimated 2%, a strategy of fundamental importance for preserving biodiversity. To realize the objectives set at the World Summit for Sustainable Development for achieving measurable reductions in the loss of biodiversity by 2010 will require the ability to measure current levels of biodiversity and changes in them; strategies to do this have been presented in a recent report from the Royal Society. The CBD secretariat is undertaking steps to achieve this objective, but it is a massive responsibility that we all share. Overall, the constructive actions of the UK government, including the Darwin Initiative, are significant in this context; they should be strengthened to the extent possible. The number of species that will survive this century clearly depends on us, the most significant contributions that we can make to preserving species will come about as part of a commitment to global sustainability, and not only because of individual biodiversity activities, regardless of how significant. The numbers of species, the amount of genetic variability within those species, and the extent of the relatively intact ecosystems that still exist in 100 years will be greatest if we can find the means and the will to commit ourselves and our nations to the goal of global sustainability.

In the words of Gandhi, which are most appropriate as we chart our course for the new millennium, "The world provides enough to satisfy everyman's need, but not everyman's greed." The appropriateness and beauty of these words illustrates why Wilson (1993) was able to conclude that humanity would be able to overcome its drive to environmental domination and self-propagation with reason -- why, in short, we are not necessarily suicidal in our approach to the world. In the spirit of Gandhi, one of the greatest leaders of our century, let us take his thoughts to heart and find the new inspiration that we so badly need at this incredibly challenging time. Global arguments may have little impact on the

behaviours of individuals unless they perceive the crisis as unbearably severe, something that impinges on people's lives in dramatic and frightening ways. By then it will be too late. Our ethics and our values must change, and they must change because we come to understand that by changing we will be happier people, guaranteeing a decent future for our children on a healthier planet in more vibrant democracy in better neighbourhoods and communities. We can succeed fully in our common task only if we learn to love one another, and especially the less fortunate of the world's people, well enough to overcome the outmoded customs, desires, and ways of thinking that we have inherited from the past.

Many of the world's life-support systems are deteriorating rapidly and visibly, and it is clear that in the future our planet will be less diverse, less resilient, and less interesting than it is now. In the face of these trends, the most important truth is that the actual dimensions of that world will depend on what we do with our many institutions, and with the spiritual dimensions of our own dedication. Clearly, the opportunities we have now are very much greater than those available earlier, but the risks we confront in our partially depleted world are far greater also.

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