

**One among millions of species, we have a parochial, but legitimate, interest in our own survival**

It takes a particular kind of genius or deep understanding to transcend this most pervasive of all conceptual biases and to capture a phenomenon by grasping a proper scale beyond the measuring rods of our own world. Phenomena unfold on their own appropriate scales of space and time and may be invisible in our myopic world of dimensions assessed by comparison with human height and times metered by human life spans. So much of accumulating importance at earthly scales--the results of geological erosion, evolutionary changes in lineages--is invisible by the measuring rod of a human life. So much that matters to particles in the microscopic world of molecules--the history of a dust grain subject to Brownian motion, the fate of shrunken people in "Fantastic Voyage" or "Inner Space"--either averages out to stability at our scale or simply stands below our limits of perception.

The case at hand is a classic representative of a genre (environmentalists versus developers) made familiar in recent struggles to save endangered populations--the snail darter of a few years back, or the northern spotted owl versus timber interests (decided, properly in my view, for the birds).

The University of Arizona, with the backing of an international consortium of astronomers, wishes to build a complex of telescopes atop Mount Graham in southeastern Arizona (part of the Gadsden Purchase). But the old-growth spruce-fir habitat on the mountaintop forms the heart of the range for *Tamiasciurus hudsonicus grahamensis*, the Mount Graham red squirrel--a distinct subspecies that lives nowhere else and that forms the southernmost population of the entire species. The population has already been reduced to some 100 survivors, and destruction of several acres of spruce-fir growth (to build the telescopes) within the 700 or so remaining acres of best habitat might well administer a coup de grace to this fragile population.

I cannot state an expert opinion on details of this controversy. Many questions need to be answered. Is the squirrel population already too small to survive in any case? If not, could the population, with proper management, coexist with the telescopes in the remaining habitat? (Environmentalists fear change of microclimate as much or more than loss of acreage. Reduction of forest canopy will increase wind and sun, producing a drop in humidity. The squirrels survive winter by storing unopened cones in food caches beside trees. If humidity falls, cones may dry out and open, causing loss of seeds and destruction of food.)

I do not think that, practically or morally, we can defend a policy of saving every

distinct local population of organisms. I can cite a good rationale for the preservation of species--for each species is a unique and separate natural object that, once lost, can never be reconstituted. But subspecies are distinct local populations of species with broader geographical ranges. Subspecies are dynamic, interbreedable, and constantly changing; what then are we saving by declaring them all inviolate? Thus, I confess that I do not agree with all arguments advanced by defenders of the Mount Graham red squirrel. One leaflet, for example, argues: "The population has been recently shown to have a fixed, homozygous allele which is unique in Western North America." Sorry folks. I will stoutly defend species, but we cannot ask for the preservation of every distinctive gene, unless we find a way to abolish death itself (for many organisms carry unique mutations).

No, I think that for local populations of species with broader ranges, the brief for preservation must be made on a case by case basis, not a general principle of preservation (lest the environmental movement ultimately lose popular support for trying to freeze a dynamic evolutionary world in status quo). On this proper basis of individual merit, I am entirely persuaded that the Mount Graham red squirrel should be protected and the astronomical observatory built elsewhere--and for two reasons.

First, the squirrel itself: the Mount Graham red is an unusually interesting local population within an important species. It is isolated from all other populations and forms the southernmost extreme of the species' range. Such peripheral populations, living in marginal habitats, are of special interest to students of evolution.

Second, the habitat: environmentalists continually face the political reality that support and funding can be won for soft, cuddly, and "attractive" animals, but not for slimy, grubby, and ugly creatures (of potentially greater evolutionary interest and practical significance) or for habitats. This situation has led to the practical concept of "umbrella" or "indicator" species--surrogates for a larger ecological entity worthy of preservation. Thus, the giant panda (really quite a boring and ornery creature despite its good looks) raises money to save the remaining bamboo forests of China (and a plethora of other endangered creatures with no political clout); the northern spotted owl has just rescued some magnificent stands of old-growth giant cedars, Douglas fir, and redwoods (and I say hosanna); and the Mount Graham red squirrel may save a rare and precious habitat of extraordinary evolutionary interest.

The Pinaleno Mountains, reaching 10,720 feet at Mount Graham, are an isolated fault-block range separated from others by alluvial and desert valleys that dip to less than 3,000 feet in elevation. The high peaks of the Pinalenos contain an important and unusual fauna for two reasons. First, they harbor a junction of two biogeographic provinces: the Nearctic, or northern, by way of the Colorado Plateau, and the Neotropical, or southern, via the Mexican Plateau. The Mount Graham red squirrel (a northern species) can live this far south because high elevations reproduce the climate

and habitat found near sea level in the more congenial north. Second, and more important to evolutionists, the old-growth spruce-fir habitats on the high peaks of the Pinalenos are isolated "sky islands"--10,000-year-old remnants of a habitat more widely spread over the region of the Gadsden Purchase during the height of the last Ice Age. In evolutionary terms, these isolated pieces of habitat are true islands--patches of more northern microclimate surrounded by southern desert. They are functionally equivalent to bits of land in the ocean. Consider the role that islands (like the Galapagos) have played both in developing the concepts of evolutionary theory and in acting as cradles of origin (through isolation) or vestiges of preservation for biological novelties.

Thus, whether or not the telescopes will drive the Mount Graham red squirrel to extinction (an unsettled question well outside my area of expertise), the sky islands of the Pinalenos are precious habitats that should not be compromised. Let the Mount Graham red squirrel, so worthy of preservation in its own right, also serve as an indicator species for the unique and fragile habitat that it occupies.

But why should I, a confirmed eastern urbanite who has already disclaimed all concern for the Gadsden Purchase, choose to involve myself in the case of the Mount Graham red squirrel? The answer, unsurprisingly, is that I have been enlisted--involuntarily, unawares, and on the wrong side to boot. I am simply fighting mad, and fighting back.

The June 7, 1990, Wall Street Journal ran a pro-development, anti-squirrel opinion piece by Michael D. Copeland (identified as "executive director of the Political Economy Research Center in Bozeman, Montana") under the patently absurd title: "No Red Squirrels? Mother Nature May Be Better Off." (I can at least grasp, while still rejecting, the claim that nature would be no worse off if the squirrels died, but I am utterly befuddled at how anyone could argue that the squirrels inflict a positive harm upon the mother of us all!) In any case, Copeland misunderstood my writings in formulating a supposedly scientific argument for his position.

Now, scarcely a day goes by when I do not read a misrepresentation of my views (usually by creationists, racists, or football fans, in order of frequency). My response to nearly all misquotation is the effective retort of preference: utter silence. (Honorable intellectual disagreement should always be addressed; misquotation should be ignored, when possible and politically practical.) I make an exception in this case because Copeland cited me in the service of a classic false argument--indeed, the standard, almost canonical misuse of my profession of paleontology in debates about extinction. Paleontologists have been enlisted again and again, in opposition to our actual opinions and in support of attitudes that most of us regard as anathema, to uphold arguments by developers about the irrelevance (or even, in this case, the benevolence) of modern anthropogenic extinction. This standard error is a classic example of failure to understand the importance of scale--thus I return to the premise and structure of my

introductory paragraphs (did you really think that I waffled on so long about scale only so that I could talk about the Gadsden Purchase?).

Paleontologists do discuss the inevitability of extinction for all species--in the long run and on the broad scale of geological time. We are fond of saying that 99 percent or more of all species that ever lived are now extinct. (My colleague Dave Raup often opens talks on extinction with a zinging one-liner: "To a first approximation, all species are extinct.") We do therefore identify extinction as the normal fate of species. We also talk a lot--more of late since new data have made the field so exciting--about the mass extinctions that punctuate the history of life from time to time. We do discuss the issue of eventual "recovery" from these extinctions, in the sense that life does rebuild or surpass its former diversity after several million years. Finally, we do allow that mass extinctions break up stable faunas and, in this sense, permit or even foster evolutionary innovations well down the road (including the dominance of mammals and the eventual origin of humans, following the death of dinosaurs).

From this set of statements about extinction in the fullness of geological time (on scales of millions of years), some apologists for development have argued that extinction at any scale (even of local populations within years or decades) poses no biological worry but, on the contrary, must be viewed as a comfortable part of an inevitable natural order. Or so Copeland states:

Suppose we lost a species. How devastating would that be? "Mass extinctions have been recorded since the dawn of paleontology," writes Harvard paleontologist Stephen Gould ... the most severe of these occurred approximately 250 million years ago ... with an estimated 96 percent extinction of species, says Mr. Gould. ... There is general agreement among scientists that today's species represent a small proportion of all those that have ever existed--probably less than 1 percent. This means that more than 99 percent of all species ever living have become extinct.

From these facts, largely irrelevant to red squirrels on Mount Graham, Copeland makes inferences about the benevolence of extinction in general (although the argument applies only to geological scales):

Yet, in spite of these extinctions, both Mr. Gould and University of Chicago paleontologist Jack Sepkoski say that the actual number of living species has probably increased over time. [True, but not as a result of mass extinctions, despite Copeland's next sentence.] The "niches" created by extinctions provide an opportunity for a vigorous development of new species.... Thus, evolutionary history appears to have been characterized by millions of species extinctions and subsequent increases in species numbers. Indeed, by attempting to preserve species living on the brink of extinction, we may be wasting time, effort and money on animals that will disappear over time, regardless of our efforts.

But all will "disappear over time, regardless of our efforts"--millions of years from now for most species if we don't interfere. The mean life span of marine invertebrate species lies between 5 and 10 million years; terrestrial vertebrate species turn over more rapidly, but still average in the millions. By contrast, Homo sapiens may be only 250,000 years old or so and may enjoy a considerable future if we don't self-destruct. Similarly, recovery from mass extinction takes its natural measure in millions of years--as much as 10 million or more for fully rekindled diversity after major catastrophic events.

These are the natural time scales of evolution and geology on our planet. But what can such vastness possibly mean for our legitimately parochial interest in ourselves, our ethnic groups, our nations, our cultural traditions, our bloodlines? Of what conceivable significance to us is the prospect of recovery from mass extinction 10 million years down the road if our entire species, not to mention our personal family lineage, has so little prospect of surviving that long?

Capacity for recovery at geological scales has no bearing whatever upon the meaning of extinction today. We are not protecting Mount Graham red squirrels because we fear for global stability in a distant future not likely to include us. We are trying to preserve populations and environments because the comfort and decency of our present lives, and those of fellow species that share our planet, depend upon such stability. Mass extinctions may not threaten distant futures, but they are decidedly unpleasant for species in the throes of their power (particularly if triggered by such truly catastrophic events as extraterrestrial impact). At the appropriate scale of our lives, we are just a species in the midst of such a moment. And to say that we should let the squirrels go (at our immediate scale) because all species eventually die (at geological scales) makes about as much sense as arguing that we shouldn't treat an easily curable childhood infection because all humans are ultimately and inevitably mortal. I love geological time--a wondrous and expansive notion that sets the foundation of my chosen profession, but such immensity is not the proper scale of my personal life.

The same issue of scale underlies the main contributions that my profession of paleontology might make to our larger search for an environmental ethic. This decade, a prelude to the millennium, is widely and correctly viewed as a turning point that will lead either to environmental perdition or stabilization. We have fouled local nests before and driven regional faunas to extinction, but we have never been able to unleash planetary effects before our current concern with ozone holes and putative global warming. In this context, we are searching for proper themes and language to express our environmental worries.

I don't know that paleontology has a great deal to offer, but I would advance one geological insight to combat a well-meaning, but seriously flawed (and all too common), position and to focus attention on the right issue at the proper scale.

Two linked arguments are often promoted as a basis for an environmental ethic:

1. That we live on a fragile planet now subject to permanent derailment and disruption by human intervention;
2. That humans must learn to act as stewards for this threatened world.

Such views, however well intentioned, are rooted in the old sin of pride and exaggerated self-importance. We are one among millions of species, stewards of nothing. By what argument could we, arising just a geological microsecond ago, become responsible for the affairs of a world 4.5 billion years old, teeming with life that has been evolving and diversifying for at least three-quarters of that immense span? Nature does not exist for us, had no idea we were coming, and doesn't give a damn about us.

This assertion of ultimate impotence could be countered if we, despite our late arrival, now held power over the planet's future (argument number one above). But we don't, despite popular misperception of our might. We are virtually powerless over the earth at our planet's own geological time scale. All the megatonnage in our nuclear arsenals yield but one ten-thousandth the power of the asteroid that might have triggered the Cretaceous mass extinction. Yet the earth survived that larger shock and, in wiping out dinosaurs, paved the road for the evolution of large mammals, including humans. We fear global warming, yet even the most radical model yields an earth far cooler than many happy and prosperous times of a prehuman past. We can surely destroy ourselves, and take many other species with us, but we can barely dent bacterial diversity and will surely not remove many million species of insects and mites. On geological scales, our planet will take good care of itself and let time clear the impact of any human malfeasance. The earth need never seek a henchman to wreak Henry's vengeance upon Thomas a Becket: "Who will free me from this turbulent priest?" Our planet simply waits.

People who do not appreciate the fundamental principle of appropriate scales often misread such an argument as a claim that we may therefore cease to worry about environmental deterioration--just as Copeland argued falsely that we need not fret about extinction. But I raise the same counterargument. We cannot threaten at geological scales, but such vastness is entirely inappropriate. We have a legitimately parochial interest in our own lives, the happiness and prosperity of our children, the suffering of our fellows. The planet will recover from nuclear holocaust, but we will be killed and maimed by the billions, and our cultures will perish. The earth will prosper if polar icecaps melt under a global greenhouse, but most of our major cities, built at sea level as ports and harbors, will founder, and changing agricultural patterns will uproot our populations.

We must squarely face an unpleasant historical fact. The conservation movement

was born, in large part, as an elitest attempt by wealthy social leaders to preserve wilderness as a domain for patrician leisure and contemplation (against the image, so to speak, of poor immigrants traipsing in hordes through the woods with their Sunday picnic baskets). We have never entirely shaken this legacy of environmentalism as something opposed to immediate human needs, particularly of the impoverished and unfortunate. But the Third World expands and contains most of the pristine habitat that we yearn to preserve. Environmental movements cannot prevail until they convince people that clean air and water, solar power, recycling, and reforestation are best solutions (as they are) for human needs at human scales--and not for impossibly distant planetary futures.

I have a decidedly unradical suggestion to make about an appropriate environmental ethic--one rooted, with this entire essay, in the issue of appropriate human scale versus the majesty, but irrelevance, of geological time. I have never been much attracted to the Kantian categorical imperative in searching for an ethic--to moral laws that are absolute and unconditional and do not involve any ulterior motive or end. The world is too complex and sloppy for such uncompromising attitudes (and God help us if we embrace the wrong principle, and then fight wars, kill, and maim in our absolute certainty). I prefer the messier "hypothetical imperatives" that invoke desire, negotiation, and reciprocity. Of these "lesser," but altogether wiser and deeper, principles, one has stood out for its independent derivation, with different words but to the same effect, in culture after culture. I imagine that our various societies grope toward this principle because structural stability, and basic decency necessary for any tolerable life, demand such a maxim. Christians call this principle the "golden rule"; Plato, Hillel, and Confucius knew the same maxim by other names. I cannot think of a better principle based on enlightened self-interest. If we all treated others as we wish to be treated ourselves, then decency and stability would have to prevail.

I suggest that we execute such a pact with our planet. She holds all the cards and has immense power over us--so such a compact, which we desperately need but she does not at her own time scale, would be a blessing for us, and an indulgence for her. We had better sign the papers while she is still willing to make a deal. If we treat her nicely, she will keep us going for a while. If we scratch her, she will bleed, kick us out, bandage up, and go about her business at her planetary scale. Poor Richard told us that "necessity never made a good bargain," but the earth is kinder than human agents in the "art of the deal." She will uphold her end; we must now go and do likewise.

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By Stephen Jay Gould