A Report on Paul Ehrlich's

Human Natures: Genes, Cultures, and the Human Prospect

by Bill Frazier

Chapter One: Evolution and Us

Since the beginning of time, philosophers, artists, and scientists alike have tried to find the answers to the questions: Who are we? Where are we going? How did we get here? How can we make the world a better place—not just for ourselves, but also for our children and their children? Paul Ehrlich takes a crack at these and other important considerations in a wide-ranging, multidisciplinary book that tries to bring us up to date on the most recent scientific knowledge from both soft and hard sciences, and weave them into a seamless whole that helps us grasp the answers to basic and practical questions. It is a line of inquiry and scholarship he hopes others will pick up and follow—for the sake of humanity.

Why is it important to understand evolution? Isn't it just about genes and distant ape relatives and fossil records? Ehrlich says it lays the foundation for understanding the most serious and complex problems facing humanity. War, genocide, commerce in drugs, racial and religious prejudice, extreme economic inequality, and the destruction of society's life-support systems all can be traced to the same long, slow and complex evolutionary interactions that led to our amazing brains and the diversity of languages.

Why do you want Beef Wellington so badly? What about that triple chocolate sundae? Evolution can help us here too.

There is a basic misconception about who we are. You can't change human nature. And yet we can, and do all the time. There is no one unchanging human nature that makes us instinctively aggressive, greedy, sex-crazed creatures. Ehrlich suggests the plural: human natures, the diverse and evolving behaviors, beliefs, and attitudes of Homo sapiens and the evolved physical structures that govern and participate in our unique mental functioning. We need to remember that biology makes sense only in light of culture. And evolution is an ongoing, powerful force that has given each of us a unique nature.

Consider the classic case of Chang and Eng, Siamese twins who lived in the U.S. around the time of the Civil War. These two vastly different brothers owned slaves, married sisters and produced many children. Chang and Eng demonstrate conclusively that genetic identity doesn't produce identical natures. Chang was quick-tempered and drank

a lot; by contrast, Eng was submissive and agreeable.

The nature-nurture dichotomy is largely a manufactured one. All characteristics of all organisms are the result of the simultaneous influence of both. Our evolution since the invention of agriculture 10,000 years ago has been overwhelmingly cultural, but genetic and cultural evolution are not independent. Coevolution is the key to understanding.

It would make no sense for evolution to program us as automata. Biological evolution has produced the most astonishingly adaptable device that ever existed—the human nervous system. It uses one organ, the brain, to accomplish a dazzling variety of novel tasks. Inherited rules to reduce flexibility make no sense when seen in this light.

Further proof is the evidence that infants taken from one society and reared in another develop the behaviors and competences of the society in which they are reared. The vast majority—85% of our genetic differences—is not between "races" or ethnic groups, but between individuals within groups.

We need to be careful and conscious in our dialogue about these and other issues to be, as David Hume put it, "rational and skeptical," in light of our overwhelming lack of precise knowledge. There is an extreme reductionist approach to a genetically programmed view of human nature that is prevalent today. It says we are merely self-copying products of our genes. But there are no individual genes responsible for individual characteristics. The number of genes this would require is staggering. Human beings have 100,000 genes, and human brains have more than 1 trillion nerve cells with up to 1,000 trillion connections (synapses) between them. This is what Ehrlich calls a serious "gene shortage."

Human beings are complex individuals with indivisible interactions occurring constantly between genes and environment and between biology and culture. Genes can't do everything. They can't even do one thing at a time, as Ehrlich points out in his analysis of the DDT experiments with fruit flies he conducted with Robert Sokal in the 1950's.

Flies bred for DDT resistance also developed edge-pupation behavior; later selecting flies simply for edge-pupation also gave you flies resistant to DDT. Selection operating on one trait normally will change others.

Chapter Two: Tales from the Animal House

Antibiotic-resistant bacteria and pesticide-resistant insects, mites, and rats are a grim testimony both to the efficacy of natural selection and to the folly of ignoring what is known about evolution.

Shortly after WWII, DDT was used to control houseflies. This was initially so successful that fly populations plummeted. As a result, people stopped using the more standard fly control practices that had been in place, such as covering garbage cans and disposing of lawn clippings. When the inevitable evolution of DDT resistance took place, housefly populations not only rebounded; they soared to even higher levels.

Large-scale rapid changes produced by human activities have allowed scientists to detect the changes produced by selection quite easily. In 1848 the speckled form of the peppered moth made up 99% of its population. Fifty years later, due to soot pollution caused by industrialization, 99% of the moths were melanic (black).

The secret to evolution is vast amounts of time. The mechanism that drives it is selection. Selection is the only known process that can produce the evolution of structures or behaviors that adapt organisms to their ever-changing environment. Look at human beings and chimpanzees. We have undergone 250,000 generations of natural selection since our ancestors took different evolutionary paths over 5 million years ago. The explanation for differences in selection is the environment in which individuals mature.

Islands are great places to see selection in action. Typically, organisms can't disperse, and they develop less physical ability than their continental counterparts. Flightless rails, dodos, and kiwis are all examples of flightlessness evolving on islands. And selection doesn't possess foresight. Take, for instance, the fate of the passenger pigeon, whose defense was to form gigantic nesting colonies of more than a billion birds at different places each year, effectively swamping and outwitting their predators—until, that is, people with railroads and guns entered the picture. The last survivor of that species, Martha, died in the Cincinnati Zoo in 1914.

Rapid environmental change can produce tragic consequences like these, due to what Ehrlich calls "evolutionary hangovers."

Millions of years of eating plants have given hominids detoxification mechanisms for many poisons. But the earth is now awash in novel, synthetic chemicals, some of which mimic hormones; many are toxic, carcinogenic, or mutagenic. These are difficult for the body to break down. Sperm counts are decreasing, perhaps in response to synthetic hormone mimics.

Even positive changes can sometimes have negative results, as is the case with women having fewer children. Continuous menstrual cycling is a factor in rising rates of uterine and breast cancer.

Sickle cell anemia shows how selection has difficulty influencing one characteristic. It also illuminates the interaction between genetic and cultural evolution. The sickle cells

produce individuals that are more resistant to malaria and less likely to be anemic. As people of African origin leave areas where malaria is common, the sickle cell gradually decreases.

Chapter Three: Our Natures and Theirs

The classic case of coevolution is the interaction between plants and the organisms that feed on them. Plants develop chemical defenses to poison, disorient, intoxicate, starve, or trap the creatures that try to eat them. The organisms that eat plants (herbivores)—from viruses to mammals—evolve ways to avoid or detoxify the chemicals. This is important to us because the herbivorous pests we hate have evolved enzyme systems to detoxify poisons. Thus, pesticides tend to have a more deleterious effect on the predators that attack the pests than on the pests themselves.

Coevolution is reflected in the interaction between the earth's biota (plants, animals, and microorganisms) and its climate. Solar energy is absorbed in forests and reflected away in deserts. Plants hold soil in place and alter the hydrologic (water) cycle. Climate changes alter selection pressures on all organisms.

Human races are arbitrarily defined entities. Widespread species can be divided into any number of "subspecies" by selecting certain characteristics. In human variation, patterns of one characteristic—e.g., skin color—do not correlate geographically with others—e.g., nose width, height, head shape, and hair structure. Dividing humanity by skin color is "nonsensical" in an evolutionary sense, and "inconsistent with genetic evidence."

In Lake Victoria there were, until recently, 500 cichlid species. Speciation occurred rapidly; all derive from a common ancestor a few thousand years ago. Runoff from agriculture has contributed to half the species disappearing between 1982-1986. Before Darwin, people never thought about extinction; the common view was that Earth's plants and animals were produced in one miraculous episode, a carefully designed chain of being from which no links could disappear. We have, painfully and sometimes tragically, learned otherwise.

So how did diversity arise? Species found on an island are more related to those of the nearest continent than to species on similar islands in different parts of the world. Also, the degree of similarity is related to the depth of the channels—a sign of how recently the land areas were connected. The grand diversification called macroevolution started with variations in environment. No two environments are identical. No environment is constant. Seasonal weather cycles, changes in climate, changes in topography through erosion, seabed spreading, mountain building or alteration of the courses of streams promote the evolution of different species. Changes in each species' population force changes in others that interact with it. The extermination of passenger pigeons, which fed

on beechnuts, made more beechnuts available to deer mice. This led to an explosion in the mouse and tick population, which led to more Lyme disease.

Under the Ernst Mayer model of geographic speciation, two populations of a single ancestor become isolated, or allopatric. Their environments then change, in turn changing selection pressures. Over time, chance mutations and the random effects of genetic drift influence the two populations differently. Later, the climate changes again and the groups reunite, but they remain distinct and unable to breed; speciation has occurred. This predicts the diverse patterns we see in organisms at any one time. These patterns relate to the mobility of organisms, the composition of communities, environmental differences, selection pressures, and the degree and time of isolation.

Chapter Four: Standing Up for Ourselves

Make no mistake: we are very much mammals—specifically, primates. Where are we to find the physical foundations of human nature if not in the study of our common ancestors? Thirty million years ago you can find the common ancestor we share with Old World monkeys. Five million years ago we split from the evolutionary line leading to chimps and bonobos. In 1758 Carolus Linnaeus classified us as primates, although the best living primate model is actually bonobos.

Cultural transmission, handedness, an obsession with sex, and proportionately the largest penises are all things we share. Chimps make tools and weapons, are skillful at forming alliances, and make up after quarreling.

The biggest difference between humans and other apes is our brains and our use of language. Our cultural endowment is great; knowledge is rapidly expanded and shared.

During the cretaceous period, 140-165 million years ago, flowering plants became diverse and abundant. Primates evolved the habit of gathering insects at night, snatching them from vegetation with dexterous fingers. Fifty million years ago primates diversified. We departed from the trees as Africa's climate dried out and savannas formed. From ten to five million years ago gorillas stayed in the forest and hominids moved out to the open country.

From Australopithecus, 3.2-2.5 million years ago, to Homo erectus, 1.5-0.4 million years ago, to Homo sapiens, 0.5 million years ago, to the present, a wealth of detail about our evolutionary history is now available. When scientists call evolution "a theory," what they mean is the highest level of certainty for comprehensive ideas: a meaning closer to the word "fact."

Chapter Five: Bare Bones and a Few Stones

The Oldowan technology of Homo habilis/rudolfensis, from 2.5-1.7 million years ago, shows clearly the handedness and specialization of brain function associated with modern asymmetrical brain development. They show substantial foresight, manual dexterity and strong intuitive knowledge of dimensional geography. Although they still may have been climbing trees, and would be out of place at a modern dinner party, they provide an excellent link between earlier primates and us. Oldowan technology lasted for 800,000 years and differed from place to place, according to both environmental conditions and skills.

Homo ergaster lived from 1.8 million years ago to 1 million years ago and represents the first "Naked Ape." Sometimes reaching 6' tall with an endocranial capacity 30% greater than habilis, he is the first of our ancestors to lose his fur. He showed no signs of living in trees and developed an advanced Acheulean technology with axes 8"-10" long. Homo ergaster was also the first to leave Africa and led to Homo erectus at least 600,000 years ago. Neanderthals are now thought to represent a species in their own right, coexisting with Homo sapiens for hundreds of thousands of years—dying out only 30,000 years ago!

Modern humans share a common ancestry that spread rapidly out of East Africa 50,000 years ago, replacing pre-modern people as they went.

Upper Paleolithic technology, with its blade-like tools, appears in the Middle East about 40,000 years ago, and brings us full force into the rapid and radical cultural change that characterizes modern humanity.

Chapter Six: Evolving Brains, Evolving Minds

Evolution is the key to the mind. The brain is unique among the organs of the body in requiring feedback from experience in order to develop. The brain is an organ that evolved by the same processes as did fins, lungs, and hearts.

Descartes was wrong, says Ehrlich, agreeing with Antonio Damasio; there is no divide between a material body and nonphysical mind. Most scientists now assume thoughts are physical events with physical consequences. Starting with Chomsky and Jerry Fodor, the popular view is that different physical parts of the brain control different faculties. Fodor concluded that perceptual and computational processes are not only localized, built into "modules" that minimize the amount of neural wiring required, but also domain-specific, or autonomous to a large degree.

Many "programs" have been built into the brain by natural selection. These patterns of

connections among neurons contain assumptions about the physical world. The main physiological characteristics of our perceptual system were established tens of millions of years ago.

Perception is a hypothesis inferred from limited sensory data. Our brains are programmed to see what we expect to see. Gestalt Laws are largely genetically determined parts of our hypothesis-generating machinery, activated by early visual experience.

Philosopher David Hume postulated automatic perception of cause and effect in the eighteenth century. A.E. Michotte supported the idea, and the "Michotte Effect" was demonstrated in 27-week-old infants by Leslie and Stephanie Keeble.

There are also cultural differences in perception, such as interpreting a picture in a two-dimensional manner. Colin Turnbull reports Mbuti Pygmy Kenge as seeing buffalo from a distance and asking, "What sort of insects are they?" Susceptibility to illusions depends on the environment in which you grow up—whether it was carpentered, or had wide vistas. What all this means is that the behaviorist view of people as "blank slates" is as wrong as the view that genes have mostly hardwired our brains. Ehrlich refers again to the "gene shortage" involved in such a view.

Perception holds the environmental background constant in order to detect sudden changes. Habituation tunes out any constant stimulus. Our nervous system filters, and our brain interprets inputs, constructing a reality we believe is "out there." These biologically evolved propensities make it difficult for us to deal with the gradual changes taking place over decades that now threaten us. Population growth, global warming, loss of biodiversity, land degradation, and accumulation of hormone-mimicking chemicals are changes our perceptual systems have evolved to encourage us to ignore.

Chapter Seven: From Grooming to Gossip

What is language, and how did this unique communication system evolve? Language is intimately connected to our thinking. It is also an excellent area in which to investigate how heredity and environment work together.

A language has three main elements: vocabulary, syntax, and meaning. It is the symbolic nature of human language that differentiates it from other primates. *Eat* is an arbitrary symbol for consuming something. *Full* is an arbitrary symbol for how one feels; both are content words. In contrast, *an*, *the*, and *not* are arbitrary syntactic symbols (function words) that specify relationships between content words. The development of syntax opens up an infinity of worlds.

“Colorless green ideas dream furiously.”

Noam Chomsky’s famous phrase of proper syntax without meaning has been cited to support a genetic program for language acquisition. The Universal Grammar idea proposes that sentences are not simple, linear strings of words; rather, they consist of underlying hierarchical structures.

Ehrlich reminds us of his “gene shortage” problem and says it is more likely to assume a genetically determined period in which the developing wiring in the brain of a child exposed to any language can make the right connections.

There are more than 5,000 existing languages, all of them sharing a somewhat recent common origin, no more than 50,000 years in the past. But there are good reasons to believe that brains, intense social interaction, and language coevolved gradually. Even in birds and frogs the left hemisphere is more heavily involved in vocalization. Dogs can recognize more than 60 words; monkeys can count; mongooses transmit complex information about predators.

The notion that a high level of intelligence came first, followed by language as a by-product seems untenable to Ehrlich. The position of the larynx in infant Homo sapiens is the same as in apes and all other mammals. But by two years of age, the larynx has dropped, creating a larger air space, the supralaryngeal vocal tract or SVT. This is great for talking, but poses serious perils such as choking. Fossil records show the gradual change in evolutionary time: Australopithecus had an ape-like configuration, Homo habilis was not complete, and Homo erectus had an intermediate position. In archaic Homo sapiens 300,000 years ago, the transition is complete.

Another evolutionary correlation is that social behavior, language, and tool making are tightly related. The neural machinery for accurate throwing or precise hammering is the same as that involved in controlling speech.

The number of individuals in a primate group is related to the ratio of the size of the neocortex to the rest of the brain. Robin Dunbar tied information processing capacity to grooming, the social glue that bonds primate groups. Is language a substitute for grooming? Have we evolved from grooming to gossip? Has group size created selection pressures for the neocortex to grow?

Ehrlich doesn’t really answer these questions as much as present all the available, sometimes intriguing, often fantastic hypotheses that abound. What he does say in conclusion is that the Great Leap Forward that occurred 50,000 years ago—the flowering of fine tool making, sculpture, cave painting, body ornaments, and ceremonies—wasn’t necessarily any more spectacular than the subsequent agricultural and industrial revolutions. The same processes that produced the grace of flying swallows, the

marvelously skilled and sensitive trunks of elephants, the stupendous size of sequoia trees, and the deadly E. Coli, also produced the underpinnings of our diverse natures: our amazing brains, and our equally amazing linguistic abilities.

Chapter Eight: Blood's a Rover

Quoting a line from an English poet, Ehrlich asks us to remember the last time we passed an hour without thinking about either food or sex, and then says, "I didn't think you could." Food and sex—or, more broadly, acquiring energy and perpetuating one's kind—are requirements for all organisms.

Until the agricultural revolution 10,000 years ago, life for hominids was one of mostly gathering and scavenging, and sometimes hunting. This lifestyle of eating wild plants, gathering mussels on rocky shorelines or catching and killing game lasted for 250,000 generations or 5 million years, first on the savannas and later in habitats as diverse as artic tundras and tropical forests.

Our ancestors developed intense consciousness, the capacity for speech; techniques for stone tools evolved. For more than 100,000 generations—from the time of Homo habilis 2 million years ago—we used a tool kit based on chipped rocks that changed only gradually.

Genetic evolution operates on generation time, so it is reasonable to assume that to whatever degree humanity has been shaped by genetic evolution, it has been to adapt to this lifestyle.

Homo habilis was primarily an herbivore. Homo ergaster/erectus is another story, producing the Acheulean tool kit, typified by hand axes. This helped add meat to their diet, leading to increased brain size.

Fire enters the human story 1.5 million years ago, although full mastery was achieved only 200,000 years ago. This is important because cooking can neutralize most plant toxins.

Homo sapiens don't produce a dramatic change until halfway through their history; the transition to Middle Paleolithic (Mousterian) technology, which uses denticulate, flakes retouched to give a saw tooth edge. This lasts until the Great Leap Forward, 50,000 years ago, when new weapons, elaborate stone tools, bone points, antler harpoons, ivory needles, string, thread, and sewn clothing are developed. Forty thousand years ago art suddenly flourished, yielding magnificent cave paintings, statuettes, and jewelry.

In terms of our genetic predisposition, Homo sapiens are basically a small group animal.

This may be the most important lesson to learn from our hunter-gatherer past.

Sex in human beings pervades every area of society. And those of us who believe in equal treatment of the sexes are up against a stubborn problem, one that will only be resolved by cultural evolution.

Is desire hardwired? The current tendency is to see male-female differences as controlled by genes. The author brings up a number of points. How would women behave sexually free from male domination, social constraints, and worries about pregnancy? What about female mate choice in hominid evolution? Researchers have found that women retain sperm differentially from different copulations. It's also possible that female orgasm draws seminal fluid deeper into the vagina. This opens the door to much more complex manipulations by women in regard to the resultant genes selected.

Why do women menstruate? Why is constant sexual activity a part of our natures? Most mammals have a clearly defined period of estrus. Ehrlich believes that "many sociocultural and selection pressures combined in complex ways to produce the human mating system."

In regard to homosexuality, there is abundant evidence that hormonal shifts early in development, causing changes in the embryo, can have profound effects on gender-related behavior. There is, in a sense, a wide range of "genders" in human beings—not a sharp male-gay-lesbian-female boundary. It seems unlikely that people can choose or be persuaded to adopt a sexual orientation.

Chapter Nine: The Dominance of Culture

There is no certain biological imperative for murdering, singing hymns or painting pictures. When it comes to the intertwined behaviors associated with violence, religion, and aesthetics, cultural evolution becomes dominant.

In chimp cultures dominance depends as much on coalitions as brute strength; with early hunter-gatherers, lacking a surplus of food, the advantages of dominance would have been less.

The idea that aggression is innate is too simple an explanation. Equally absurd is the Rousseauean myth that civilization corrupted a pacific humanity. Bloody warfare plagued prehistoric North America. In a Copper Eskimo group of 15 families, every adult had been involved in a homicide. From 1920-1955 murder rates among the !Kung Bushmen were 20-80 times that of industrialized societies. The Yahgran canoe nomads of Tierro del Fuego had a murder rate 10 times that of the U.S.

A study of 132 cultures says societies go to war more often as they become more stratified and technologically sophisticated. But this doesn't demonstrate causation. On the other hand, the complexity and variety of war-like behavior do not point to a genetically coded root or motive.

There are ideas used in every culture that deal with supernatural entities, agencies, or possibilities. Ideas are used to establish a coherent worldview, exercising both a manipulative and explanatory function and also an integrative and controlling function. We call this religion, and some cause and effect interpretation of observed sequences is hardwired into the human nervous system.

Burials go back 100,000 years; burials with art objects go back 50,000. Neanderthals buried their dead.

Fear is also hardwired—fear of pain, fear of predators, fear of falling, fear of abandonment, fear of the unknown. We experience dreams, trances and hallucinations, and see shadows and reflections of ourselves. We have self-consciousness. We believe there must be things beyond ordinary experience. Different ideas illustrating the complexity we are dealing with here include the belief in more than one soul; that souls can wander during dreams; and that souls are located in various organs.

In the development of Religion lies one of the first steps in social stratification—the emergence of the shaman. Sapolsky links schizophrenia with those chosen to be shamans. He also describes a connection between OCD and religious ritual. Another correlation is geography in the evolution of religion. Rain forests produce polytheistic people; deserts produce monotheisms.

There is little basis for placing religions on a scale from primitive to advanced. All people think their religion is the true one, and environmental change has little influence on it once established.

Art evolved in close association with religion. It is a major feature of all human societies. In preliterate societies it embodied communal values and knowledge. The first traces of art appear 40,000 years ago—incised bones, small statues and figurines, spectacular cave paintings. The Lascaux Grotto in Southern France and the Altamira Cave in Spain feature displays of early art.

Music and dance developed with pictorial art and sculpture around the time of the Cultural Great Leap Forward. Writing developed 5 or 6 thousand years ago in Mesopotamia and spread to Mexico, Central America and the Far East. It evolved from art—from iconic pictographs to completely symbolic representations of the sounds of speech. Art and writing added to the capacity to share extragenetic information. Writing developed in conjunction with religious practices, which require complex calendars for

rituals and keeping financial records.

Art can be aesthetic but is often a form of communication. The Lega, a rainforest people, carve female figures with extended bellies. These were thought to be fertility figures, but were actually warnings against adultery while pregnant. The Bwami ritual of initiation has strict rules about the use of art objects and who keeps them. In this sense, art helps to ensure the continuity of the social structure and maintain its stratification.

Among the Yolugu in Australia each clan possesses a series of special designs used to direct ancestral power. The aesthetic is functional.

Sex, violence, art, and religion are products of our natures that have evolved with us, and are tightly entwined. Human behaviors are complex, built on a biological foundation; but the edifice itself is the product of our cultural evolution.

Chapter Ten: From Seeds to Civilizations

How do we account for both the unity and diversity of human natures and their evolution through time? We badly need an evolutionary theory of culture that unties the social sciences, including history, into a coherent field. Most of our cultural evolution has been seen through the lens of history. Changes have been evaluated in light of human actors, motives and actions—what Ehrlich calls microevolution. Paying attention to extrinsic factors—mountain ranges as barriers, the fact that agriculture spreads easier at the same latitude, availability of animals and plants suitable for domestication—is what Ehrlich calls macroevolution. We see these two factors working together to shape both problems and solutions in human endeavors, such as WWII with Germany and Japan obtaining and defending petroleum supplies. Microevolution created the need for these liquid fuels in industrial societies.

The microevolutionary perspective has been dominant as we focus on great leaders such as Alexander the Great, George Washington, Winston Churchill; large-scale manufacturing; and the emergence of state bureaucracies. But macroevolutionary factors may be lurking in the wings in the form of rapid climate change, depletion of underground water supplies, soil erosion, loss of biodiversity, and increasing chances of global epidemics.

It's quite possible that human health declined and death rates increased with the onset of agriculture. So why did we go from seeds to civilization? Plant and animal domestication was generally a gradual process. Early hunter-gatherers were mostly gatherers and would not have been surprised by sprouting seeds in the latrine area. They no doubt encouraged the production of favorite foods by weeding, pruning and spreading seeds. That they did this before plants were brought under cultivation has been verified

by research exploring the diets of the inhabitants of Abu Hureya on the Euphrates River in Syria. People there were relying on Wild Einhorn wheat 11,000 years ago. Ehrlich concludes that the key to the spread of farming may have been the occasional periods of extreme scarcity. Herding and cultivation provided insurance against starvation. Another factor was the climate changes occurring in the Near East 13,000 years ago that expanded the range of large seeded grass species, an enormous food source. Inadvertent selection by farmers produced strains with non-shattering heads.

Birth rates accelerated as agriculture made it easier for women to provide their children with soft weaning foods. This reduced the length of lactation and its associated infertility. The sedentary lifestyle also permitted closer child spacing because women no longer carried offspring on long foraging trips or migrations.

Once people became sedentary, they invested labor in improved water flow, preparing soil, weeding, planting, caring for tree crops, and domesticating animals. This led to surplus and the division of labor, which in turn led to new social arrangements.

But how did we evolve from villages, clans, and chiefdoms to the archaic states and, eventually, to the modern nation state?

States are defined as societies that cover entire regions and include hundreds of thousands, or millions of people, often from different ethnic groups and engaged in diverse economic activities. States have well defined upper classes that profit from domination of lower classes and attempt to substitute psuedo-kin for real kin. Mother Teresa, the Holy Father, and Uncle Sam combine with families of Japanese corporations and the Mafia.

Before Robert Carniero developed the idea of circumscription, people believed the creation of states was somehow automatic or voluntary. Circumscription says that before a state can evolve, something has to prevent future subjects from fleeing their would-be rulers.

Carniero outlined three types of circumscription—geographic, resource, and social. When a circumscribed society grows to the point where there is no unused terrain, squabbles lead to warfare, and losers are subordinated; this develops a whole class of social stratification.

Political evolution led to more frequent warfare, taxation, conscription, bureaucracies, etc. The labor of subordinated people creates a surplus; this is controlled by elites, leading to even more social stratification.

The Islands of Polynesia offer as good a test for the theory of circumscription as we are likely to find. From a common ancestry 3,000 years ago, people populated islands of

different sizes, with different environmental characteristics, and independent cultural evolutions.

New Zealand, the largest of the group, has low population density over a wide geographic area, which led to the absence of any highly complex sociopolitical organization. On the North Island of New Zealand there were marine resources and rich land, which led to the evolution of a more complex political structure than that of the South Island, where there were fewer people.

So, New Zealand represents both resource circumscription and—because expansion in resource-rich areas was limited by the presence of hostile groups—social circumscription.

People arrived in Hawaii about 400 A.D. and occupied a much smaller island area, creating a population density in relation to arable land about 10 times that of New Zealand. The highest level of political evolution—basically incipient states—were found here.

The Tonga archipelago has 4% of the land area of Hawaii but was colonized earlier, (circa 1100 B.C.), and thus had a longer period for its political system to grow.

People tend to think of the Polynesian Islands as an unspoiled paradise, but that is not an accurate description. The Maori of New Zealand drove to extinction 13 or more species of moa—a flightless bird, the size of an ostrich. And then there is Easter Island. The Polynesians went there around 400 A.D. They hunted dolphins and fish from large canoes. But as their population grew to 10,000 people in the 1400s, they completely deforested the land and the slow-growing palm. This ended their fishing, and when the forest went, so did the soil, now swept away by strong, drying winds. Crops declined and warfare became common. Most of the great stone torsos (Moai) were toppled. Slavery and predatory raiding became common; cannibalism was part of the new religion. By 1900 there were 111 people left.

The fates of two other Polynesian islands are interesting to contemplate in light of both circumscription and, perhaps, our own fate. Mangaia became home to the Polynesians in 500 B.C. Pollen records show the island was quickly deforested and the topsoil destroyed by people used to the young, rich soils of the mostly volcanic islands they had recently colonized. By 1200 A.D. the people switched to irrigated taro agriculture. The fields occupied 2% of the island surface and were the target of repeated warfare. They wiped out the native birds and decimated the fauna. As resources deteriorated, chieftainships were replaced by terror and human sacrifice, offerings made to the dual god of war and irrigation.

Tikopia maintained a population density five times that of Mangaia. The Tikopians

developed an intensive system of arboriculture—orchard planting—which covered the island with valuable plants, fruit and nut trees, shading yams and other crops. Fisheries were regulated—by taboos. Population control mechanisms were strong—celibacy, contraception, abortion, infanticide, and near-suicidal sea faring by young men combined to produce zero population growth.

The tiny size of Tikopia (the island can be traversed on foot in a day) may have helped create the cooperative environment that the islanders enjoyed.

Ehrlich next takes a look at some societies that can be interpreted as exhibiting various stages of political evolution, from family based structures to ones with more complex social stratification. The Machigucuga of the Peruvian rainforest get about 1/3 of their food by hunting and the remainder from highly productive gardens. People live in farming hamlets of a few related families, although they roam periodically to take advantage of wild foods considered essential. They practice slash-and-burn agriculture. Population densities are low due to the need for long fallow periods and the desire to produce yields using the least labor. Warfare is unknown. The scarcity of resources in their environment militates against trying to hold territories.

The Yanomamo of Amazonia, on the other hand, are locally more densely populated. They invest great effort in improvements to their more permanent gardens, producing plantains and peach palm fruits over many years. These are resources worth fighting for. In a quarter-century study, the anthropologist Napoleon Chagnon found that 44% of Yanomamo males had participated in killing someone; 30% of adult males met with a violent death; and 70% of adults over 40 had lost a close relative to homicide. This tribe was completely circumscribed; it was not possible for people to flee to the adjacent islands.

Families live together in extended groups of 35 called a “teri.” Teri-level leaders in the evolutionary scheme of things probably gave way to warrior kings, leading to further complexity—to chiefdoms, states and empires. When environmental pressure integrates family and village societies into regional economies, strong leadership becomes essential. With such leadership come the first stages of social stratification as people are assigned to different classes. Ceremonies and rituals replace kinship bonds. Ceremonies also serve as material manifestations of ideologies. In more complex societies where there are armies, priesthoods and ceremonies can serve to legitimize and make mysterious the social stratification, leadership structure, and extraction of surplus by elites. Ehrlich concludes that the state developed gradually and is a brand-new social invention.

Control of surpluses makes stratification (class divisions) possible. Overall, circumscription provides basic insight into the evolution of states, but it doesn’t explain the whole picture. Societies have found diverse ways to manage external aggression and solve economic problems. Each early state evolved a unique economic blend of

exchange through markets, trade, taxation, and tribute. Crete was based on long-distance trading. Rome extracted tributes from subject people. Both environmental macroevolutionary factors, such as the proximity of coal and iron ore, and more evanescent ones like competent leadership, interact ultimately to shape and produce the more complex world in which we all reside.

Chapter Eleven: Gods, Dive-Bombers, and Bureaucracy

We can see the patterns of interaction between cultural macro- and microevolution in history by looking at the development of states and the institutions that support them: commerce, warfare, and religion. The need to understand these forces becomes more crucial as human enterprises press up against global support systems, threatening the viability of life on the planet.

The two key elements of the microevolution of state power are religion and violence. Society continues its stratification with professional priestly and warrior classes.

Organized religion evolved to help stabilize hierarchical social structure. Religious rituals provide solace, pleasure, and order to individuals; they sacralize codes of conduct as people relate to the supernatural and bring sanctity into previously nonreligious areas of life, allowing elites to remain in control. Religion, reinforced by psuedo-science, continues to maintain the status of elites today, justifying poverty and wealth as expressions of God's will.

Warfare has evolved culturally to the incorporation of the productive capacities of subjugated people into the resource flow of the conquerors, and with this development it becomes entwined with and justified by religious belief and ritual.

War restructures relationships within society, rallying support for a faltering leader; it redistributes labor and wealth. Historian Donald Kagan says, "War is the ordinary state of affairs among nations." He adds that the pursuit of fame, glory, prestige, and respect are an important reason why people go to war.

The notion that war is caused by an innate aggressive drive or individual aggressive propensities, as suggested by Irenaus Eibl Eibesfelt, is very problematic. The modern army is highly routinized, looking more like "the Internal Revenue Service than a band of Marauding Kasakela chimps," says Ehrlich. Hormonal triggers are not required to incite mass violence.

A massive amount of data suggests that it is difficult to get human beings to kill each other even during wartime. In the civil war and both World Wars more than half the men in combat either didn't fire their weapons or fired to miss.

If there is a universal to Genocide, it is dehumanizing the victim. In Rwanda and Burundi 800,000 Tutsis were killed after a long and careful campaign at the behest of the Hutu-led government. This propaganda was based largely on already existing racial and class prejudices. The best summary of the evolution of violence is that social and political systems require the manipulation of other individuals and groups, and sometimes primates will resort to any tool to achieve their ends. The argument about our "innate" aggression or pacifism is a false one.

But what about the seeming ubiquity of Genocide—government sponsored programs of mass murder? Isn't this proof of our innate aggressive character? There clearly is a resource-territoriality element; consider the treatment of Native Americans by Europeans, or that of the Tasmanians by the Australians. Resource scarcity also played a role in more recent genocides in Africa. There was clearly some resource-territory element in the German and Japanese aggression of WWII. But how can one explain "normal grown men walking little girls into the woods and shooting them in the back of the head?" Or the cruelty of the Japanese towards the Chinese, when tens of thousands of women were raped, mutilated and killed?

Genocide is clearly part of the human repertoire, and Ehrlich suspects it could be induced in any group. He cites the classic obedience to authority experiment by Stanley Milgram, in which ordinary people delivered what they thought were lethal shocks to the "learners" in their experiments.

Early in the development of states elites formed hierarchies of bureaucrats and guilds; police and priests were employed to legitimize and protect the privileges of those elites. Taxes in early states were levied on virtually all productive resources and economic activities. Gaps between rich and poor continue to exist. In 1997 the per capita gross national product of Mozambique was $80; in the U.S., $28,020. Similarly, in the U.S., the top 1% has more income than the bottom 40%.

Large states with complex economic arrangements seldom develop without writing; writing and commerce coevolved. Early Sumerian writing evolved from a system with tokens 5,000 years ago. In ancient Rome or 15th-century Europe, literate people could make a living as scribes. Even today, the global maps of illiteracy and poverty coincide.

Money—from its roots in simple exchanges at markets, to the electronic transfer of huge sums of money globally—has also transformed commerce, and thereby culture.

Cultural evolution produces different results in different places. China in the 1400s was well on its way to world domination, with an armada of 300 ships and 28,000 sailors, reaching East Africa decades before Columbus. Admiral Zheng had transports for troops and horses, patrol boats, men-of-war, and tankers holding freshwater.

Ehrlich thinks part of the answer to why Europe—as opposed to China—took control of the world may be macroevolutionary. China's lack of geographic barriers allowed single rulers to control the entire area. In Europe, competition produced innovation and the cross-fertilization of ideas. Microevolution's role was accentuated by the Chinese denigration of business; policies and attitudes that valued inwardness also contributed. The European states were too small, with too few resources to monopolize as technologies changed. Finally, there was Adam Smith, whose ideas promoted greed and self-seeking behavior.

There is no single deterministic factor unfolding to control our evolution. Perceptions of macroevolutionary factors are themselves a microevolutionary influence. Would Japan have moved to Southeast Asia if the U.S. had continued supplying them with oil? What about Hitler repeating Napoleon's error of invading Russia? The interacting natures of millions of people have produced such a complexity of events that identifying a few cultural driving forces is difficult, if not impossible.

Modern states should be viewed as one more stage in the intensification of human activities, a stage in a long-term, largely cultural macroevolutionary process. But, since Hobbes in the mid-17th century proposed that states were formed to provide security, theorists have analyzed the modern state in social, economic, and political terms; specifically, the tension between the presumed rights of individuals and the rights of states. In recent years the focus has centered on economic organization: centralized planning or communism versus market mechanisms or capitalism.

The glorification of unrestrained capitalism wasn't shared by the person most quoted by conservatives, Friedrich August Von Hayek. The Road To Serfdom did not deny the need for government planning. The creation of a strong system of laws to provide a level economic playing field, and controls to protect public health, provide personal security and preserve ecosystem services are areas where that planning might be important today.

Political theorists, as well as urban populations in general, have disconnected from the hominid biological and cultural evolution of our species and the ecosystem services on which all of our lives depend.

The production of agricultural surpluses, specialization, stratification, and the formation of cities and states has led us through what we commonly call our history, bringing us to the point where market-driven multinational corporations have wrought damage so severe that the future of civilization is brought into question. The total impact of humanity on the ecological systems that support it multiplied 25-fold between 1850-2000.

Chapter Twelve: Lessons from Our Natures

Everyone should learn our evolutionary history. Such knowledge will help us make informed decisions. Two major areas where we have failed to learn from coevolution are brought into focus next. Pesticides should only be used when other measures fail; otherwise, what we have is resistance galore. Similarly, microorganisms have developed widespread and rapid resistance. Penicillin is now useless in the treatment of many dangerous diseases, and new strains of bacterial and protozoan diseases have emerged that are resistant to all drugs; yet indiscriminate use of antibiotics continues. One of the most flagrant examples of evolutionary ignorance is the use of antibiotics as growth stimulants in animal feed. People need to be aware that there is a continuing coevolution of human beings with bacteria, fungi, and viruses. Evolving pathogens change not only resistance to human defenses, but also virulence in response to modes of transmission.

Another example of "evolutionary hangovers" is the stress response, something useful and important for hunter-gatherers with periodic short-lived crises in a relatively stable environment. Today, in a shifting world, nearly constant stresses contribute to any number of diseases.

Another long programmed predilection is the human obsession with fats and sweets. In present-day society, where soda pop, hamburgers, and candy bars abound, this propensity of ours, which served us well as hunter-gatherers, is now leading to heart disease, diabetes and cancer, not to mention the development or pace of prostate cancer.

Superoptimal stimuli are agents that produce greater responses than related natural stimuli. The tails of Kenyan long-tailed widowbirds are an example.
Junk food may represent a superoptimal stimuli for people today.

What about acquisitiveness? Is there a biological evolutionary tendency to acquire things? Acquisitiveness was certainly favored by cultural evolution; it most probably had a payoff in reproductive success also, and thus a genetic element. But there are no genes for consumption. Plenty of signs point to cultural pressures. Beyond a certain point, there is no evidence that consuming more produces more satisfaction. Our sense of well-being depends in part on the differences between others and ourselves that make up our reference group. With the advent of TV and global communication, rock stars, sports stars, business tycoons and the like now make up that reference group, leading to over consumption. An obvious evolutionary strategy would be to encourage behavioral change in those reference groups.

In regard to bureaucracies, Ehrlich says Nepotism comes naturally because our long evolutionary history has produced an emotional animal that favors kin. Human flexibility is always available, however, and many bureaucrats bend or reinterpret rules to make organizations function smoothly and help clients.

It's important to be realistic. For instance, there is abundant evidence that rules regarding abstinence will not be followed. Instead, we should try to promote conditions in which the consequences of interactions are not inimical to the goals of society.

In regard to Racism, Ehrlich takes a strong stand, saying: "few kinds of ignorance have had such a pernicious effect on society." Geographic variation in human beings does not allow Homo sapiens to be divided into natural evolutionary units, and the concept of race has disappeared from mainstream evolutionary theory. Every geographic unit within our species has a unique combination of attributes, and the pattern of variation is discordant. To divide Homo sapiens into races is to select arbitrarily one or two characteristics (usually skin color) and then throw in qualifiers. Pick a different set of characteristics and you get a different set of races. Racial categories have enormous implications—distribution of government resources, for instance; but are virtually meaningless.

Race has been a basis for social stratification, promoted genocide, and been an excuse for slavery.

What about Sexism? There is no evidence that genomes make women less capable than men in carrying out any job or activity. Sexism has a long history in science, a field dominated by white males. To what degree has this biased research in various areas? A great deal in medicine, Ehrlich thinks.

Since our understanding of gene-environment interactions is so incomplete, it would be foolish to promote genetic intervention, or even gene-replacement therapy. Even less desirable would be artificial attempts to "improve" humanity. We know so little that it would be analogous to "letting a blindfolded maniac with an axe into an operating room," says Ehrlich.

We are small group animals who evolved genetically and culturally to operate in limited, homogenous, largely closed societies. How can we now work toward our common goals as disparate groups with often-conflicting interests struggle with issues such as ozone depletion, global warming, and the collapse of oceanic fisheries? The diversity of values even within functioning communities can be staggering. Think of the U.S. and the wide, often contentious views on abortion, capital punishment, homosexuality, pornography, and gun control. There is no easy answer to this problem.

People are exposed to a much wider culture today, and cultural controls on behavior are disappearing. We need to address this decline in geographic community. Taking the long evolutionary perspective on culture we might steer a different course. We might, for instance, redesign cities so that people could walk to work. Human size communities, combined with telecommuting, World Wide Web shopping, carpooling, and better public transportation could produce healthier individuals and a healthier environment.

Chapter Thirteen: Evolution And Human Values

A modern knowledge of biological and cultural evolution helps us grasp what kind of animals we are and how we fit in the natural world. It can help us detect mismatches in trends of human endeavor. It can help us be wiser in developing a sustainable society for the future, as the tension between resource extraction and liberty heightens.

How will society divide up the resources they own? How will they organize themselves to do it? What about public access resources such as oceanic fisheries? Or rivers that run through more than one state?

Ethics are the function of a material brain that evolved gradually within groups of highly social primates. The capacity to develop ethics is a product of biological evolution. But the actual norms of any society are the result of cultural evolution. Values connected directly to an animal's feelings are called "perceived values." Values that develop indirectly by using our brains to reason our way through the intricacies of social interactions are called "conceived values." Evolution of the capacity of empathy brings the value of caring for others with it. But how far should that caring extend? Transferring technologies to poor countries has fueled a population explosion; there are serious consequences for future generations. Population growth, sooner or later, leads to enormous suffering. Should we care about future generations? How many? What about other species?

Universal values are difficult to discover. Cultural evolution is the source of ethics. Knowledge of evolution carries no normative message; evolving naturally is not always good, and good is not instinctively natural. Our subjective impressions of the natural world are emergent properties of a complex interaction between our physical organization and the world and cultural attitudes. A satisfying reductionist explanation for many of our feeling, perceptions, and behaviors may well be beyond our grasp.

The ultimate issue of environmental ethics is what constitutes each individual's responsibility for maintaining the crucial natural services ecosystems supply to humanity. We must be conscious and active in our global human society lest we repeat the fate of Easter Island on a global scale.

Overpopulation, overconsumption, continuing economic growth among the rich; and inefficient, inequitable and often iniquitous social, political and economic arrangements are already denying a decent life to over a billion people—in addition to depleting the natural capital that sustains humanity. We may be heading for the worst catastrophe in the history of Homo sapiens. But it's not too late to change. Quoting John Holdren: "The rich can become more efficient and the poor consume more."

The mechanisms, results, and significance of evolution should be taught at every level,

and the teaching of creationism as a "scientific" alternative to evolutionary theory should end.

Academic disciplines started with the Royal Societies committees, set up in neat, clockwork-style categories, where boundaries seemed coherent and comforting. Resource flow into careers created a conservative division in the world of scholarship. But few significant human problems today lie strictly within the boundaries of current disciplines. Since the Middle Ages cultural evolution has created a body of non-genetic information no single person could hope to grasp. Interdisciplinary collaboration should be encouraged.

The design of the human perceptual system makes it hard to recognize serious environmental problems. Our perceptual system evolved to hold the background constant, to detect and react to short-term events. Quick reflexes are programmed into our nervous system for the appearance of an edible animal, a member of the opposite sex, or a threat such as a lion or a rival. Today threats range from global warming, loss of biodiversity, distribution of resources, and nuclear and biological weapons. These represent gradual alterations in our environmental backdrop, and we need to develop "slow reflexes," and use them consistently. This is the groundwork for what psychologist Robert Ornstein calls "conscious evolution." Perhaps the most famous example of conscious evolution in action is the nuclear winter collaboration in 1983 between Soviet and U.S. representatives, when a broad coalition of scholars, foundations, politicians and military reached a consensus on the potential consequences of a nuclear war between the U.S. and Russia. The issue generated an intensive media campaign, much public awareness, and helped lessen the chances of war.

Ehrlich also points to the abolition of slavery in the U.S., the trend toward Democratic government, the labor movement, women's suffrage, women's rights, civil rights movements, and family planning as more hopeful developments.

We need a dialog about rehumanizing our societies. Cities need to be redesigned for people, not cars. Being able to get to work on foot, or by bike, or mass transit would increase the quality and length of individual lives, as well as reducing pollution and accidental death.

We need a systematic, interdisciplinary consideration of issues in a process that is transparent to all participants, as well as the general public and decision-makers. These are goals toward which the IPCC (Intergovernmental Panel on Climate Change) works. But Ehrlich thinks we can go much further. If we considered genetic evolution, then we wouldn't waste time trying to get people to have intercourse less often. We should also have broad participation by informed nonscientists. We have the tools—global satellite TV, the Internet, fax machines, and conference calls.

We need to consider the built-in genetic and cultural plurality of our species. We are not a blank slate, but genes influence on behavior must be limited to general capacities and propensities. Our diversity of natures is an important human resource.

There is no easy formula for human beings. We are products of gene-culture coevolution; life, no matter how much we may want to simplify it, is forever complicated. We need to see both the details where the devil lives and the big picture. We may never create a utopia, but it is certainly within our power to create a much better world. We can do it, Ehrlich says; but will we? This book can give to each of us the information we need to make a start.