NIP : 262 -
pp.1–18 (col.fig.: NIL)
PROD.TYPE: COM
ED: INDIRA
PAGN: SWARNA SCAN: XXX

PERGAMON

NEW IDEAS IN PSYCHOLOGY

New Ideas in Psychology 0 (2001) 1–18

www.elsevier.com/locate/newideapsych

Short Communications

Instant evolution. The influence of the city on human genes: a speculative case

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Abstract

The dominant view in today's evolutionary psychology is that our instincts were stamped into our DNA during the infamous EEA, "The Environment of Evolutionary Adaptedness" (Evolutionary psychology: A primer. Santa Barbara: Center for Evolutionary Psychology, University of California, 1997). This is generally reckoned as a roughly two and a half million-year hunter-gatherer phase that ended before the climax of the last Ice Age. Since then, our genetically preprogrammed heritage has supposedly been locked in stone (or better yet, in an amino acid code). We are, so says the current argument, tribal hunter-gatherers decked out in modern clothes. However a strong case can be made for the possibility that human biology has continued to evolve during the 10,000 years since Jericho's builders erected the first city walls. Genes change far more speedily than most evolutionary psychologists realize. Natural selection has had 400 generations to rework our bodies and our brains since the days when Catal Huyuk, Suberde, and Tepe Yahya joined Jericho's mesh of intercity trade. Four thousand years before the rise of the Sumerian cities of Ur, Uruk, and Kish, Stone Age metropolises from Anatolia to the edges of India were already rich in challenges and opportunities. These urban traps and niches may well have been selectors forming much of what we are today. *Homo urbanis* has not only arrived, he has long since elbowed *Homo tribalis* far off to the side.

Keywords: Human evolution; Gene-culture coevolution; EEA; Complex societies; Violence; Neolithic urbanization; Neolithic agriculture; Plague

In 1979 University of Washington zoologist David Barash published a popular exposition of the then-new discipline of sociobiology called *The Whisperings Within* (Barash, 1979). The book was rich in studies, theory, and in one of the most delicious

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0732-118X/01/$ - see front matter
PII: S0732-118X(01)00004-6

forms of scientific sweets—illustrative anecdotes. As a companion piece to Wilson's original *Sociobiology* (Wilson, 1975), *The Whisperings Within* was a delight.[1] So when 1986 rolled around and Barash published yet another popular book (Barash, 1986), *The Hare and the Tortoise: Culture, Biology, and Human Nature,* the book raised expectations of yet another scientific treat. What it delivered instead was a polemic, one in which references to research, to tales of animal behavior, and to a rich confection of anthropological surprises had ceased. Barash was now promoting a political agenda, one based on the notion that the evolution of human impulses had stopped long before the end of the last Ice Age. A living fossilization of the human brain, said Barash, was the source of many of our woes. We had the minds of cavemen but had fashioned ballistic-missile throwing stones complete with nuclear tips. Seized by caveman instincts, we were likely to bash each others' pates with our atomic clobberers, thus ending the brief existence of our oh-so-less-than-sapient human race.[2]

The nuclear nightmare was very real when Barash penned this prose. Now that atomic weaponry has spread to countries like China, Pakistan, India, and such soon-to-be nuclear powers as Iran, Iraq, Libya, and North Korea (Nuclear Age Peace Foundation, 1998), the threat is even more real today. But the notion that our evolution came to a dead halt over 10,000 years ago seemed downright suspect. If Trinidadian guppies could evolve new colors for their spots in five months (Endler, 1986) and if Galapagos finches could evolve the size of their beaks—and the nature of the genes that code them—in a year (Grant & Grant, 1989; Weiner, 1995), why should we suppose that the inborn repertoire of feelings and behaviors on which humanness is based was unalterably locked in Pleistocene chromosomes?

In the decades since Barash issued his *pronunciamento*, the notion that we are hunter-gatherers in suits and ties has become common among evolutionary psychologists and numerous lay thinkers. In scholarly journals, popular magazines, and science specials on TV, it is popular to state that we are bearers of tribal instincts whose later immersion in agriculture, commerce, city living, and advanced technology has not done a bit to change our psychobiocircuitry. Jerome Barkow, Leda Cosmides, and John Tooby made this Pleistocene fixation campus dogma in their 1992 book *The Adapted Mind* (Barkow, Cosmides, & Tooby, 1992). Stephen Pinker, a scientist with smarts and considerable clout has said, "There's an endless [list] of things that we do that make no sense from a narrow biological point of view. On the other hand, they do make sense when you recognize that every single one of them is a response to some recent bit of human technology that's been around for an eye blink in the human evolutionary scene, and that for the 99% of human existence in which we lived in nomadic hunter-gatherer bands, these temptations didn't exist" (Morton, 2000, p. ■). And David Buss, another savvy thinker in the evolutionary explanation trade, has said point blank that we live "in the modern environment," but "we have a Stone Age brain" (Morton, 2000, p. ■).

[1] Barash (1977) also showed his serious side in an excellent textbook: Sociobiology and Behavior.

[2] For another exposition of Barash's viewpoint on our antiquated instincts and our modern weaponry, see Barash and Lipton (1985).

The real irony may be that David Barash proposed the notion of the Stone Age human psyche when he was moving from sociobiology into the field of peace studies. His formulation was designed to help us get a handle on our violent side. The gentling of humanity has not been the result. To the contrary, one of those who have echoed Barash's image of cavemen playing with plutonium was a truth-seeker holed up in a cabin near Lincoln, Montana, who wrote the following words: "I attribute the social and psychological problems of modern society to the fact that society requires people to live under conditions radically different from those under which the human race evolved" (Kazcynski 1995, para. 46). The man who penned this statement and drew his inspiration from its point of view was Theodore Kazcynski, the Unabomber, who killed three people and injured 29 in the Ice-Age-and-savanna credo's name (CNN/Time Interactive, 1997).

What counts in science, however, is not a doctrine's political fruit, but the accuracy of its point of view. Do we really, as the title of one Australian Broadcasting Corporation special put it, have *Stone Age Minds in Modern Skulls* (Morton, 2000)? Are we tribal hunter-gatherers to the bone—or at least to the core of our neuronal wiring?

1. The speed limit of genes

From 1997 to 2000, this author was provided with the opportunity to review the record of human evolution from a heretic's perspective for his most recent book—*Global Brain: The Evolution of Mass Mind from the Big Bang to the 21st Century* (2000). This reevaluation of evolutionary history produced a rather large surprise. The Stone Age was not entirely the property of nomadic hunting-gathering tribes. It also hosted the rise of the first cities. To someone who had received a sound mid-20th Century education, the notion that man had urbanized 5000 years before the birth of Ur, Memphis, and Babylon came as rather a shock. Why had this not been taught in traditional courses in ancient history? What impact would an extra 250 generations of human life in the big burg and its countryside have on the evolutionary trajectory that has made us what we are today? Could it mean that we are not just men and women of the cave, the sabertooth, the mastodon, and the stone-flaked blade? Could it mean that some of us are something rather different—children of the alley, of the apartment, of the marketplace, and of the crowded downtown walkway?

The usual reason given for a no to questions of this sort is that, as John Tooby puts it: "Evolutionary change is very slow" (Morton, 2000, p.). Altering the genome, we are told, takes hundreds of thousands or millions of years, not just decades or centuries. We could not possibly have undergone significant genetic reprogramming in the ten millennia since some of our ancestors left their tribal dwellings for the lure of the big city. So let us start by tackling the question of the speed limit on shape-shifting among genes. Indications are strong that human and non-human genes can alter in astonishingly short bursts of time. If this is true, and I hope to indicate it is, then many a human chromosome may have been recrafted by such forces of

modernity as the city, long distance trade, and even the environments of nation states and of Imperial bureaucracies.

Geneticist Neil Howell, of the University of Texas' Galveston-based Medical Branch, contends that one form of human DNA—that contained in the mitochondria—sometimes makes adaptive shifts in a mere one or two generations (Howell, 1999; Bower, 1999; Nachman, Brown, Stoneking, & Aquadro, 1996).[3] The research with which he hopes to prove this is still in its infant stage. But Howell's suspicion that genes can be swift gains credibility from the rate of phenotypic change among insects and fish.

Here is an illustrative passage on the subject from Global Brain: the Evolution of Mass Mind from the Big Bang to the 21st Century (Bloom, 2000, pp. 93–94):

> If a passel of nearly identical animals is cooped up on a common turf, it frequently splinters into opposing groups which scramble determinedly down different evolutionary paths. E.O. Wilson, who brought attention to this phenomenon forty years ago, called it character displacement (Brown & Wilson, 1956; Wilson, 1971; Grant, 1994). The battle over food and *lebensraum* compels each coterie to find a separate slot in the environment from which to chisel out its needs (Schluter, 1994; Gibbons, 1996). For example a small number of lookalike cichlid fish found their way to Lake Nyasa[4] in Eastern Africa roughly 12,400 years ago. It didn't take long for the finny explorers to overpopulate the place. As food became harder to find, squabbles and serious fights probably pushed the cichlids to square off in spatting cliques. The further the groups grew apart, the more different they became.[5] The details of this process are somewhat speculative, but the result is indisputable. The cichlids rapidly went from a single species of fish to hundreds (Morell, 1999), each equipped with a crowbar to pry open opportunities others had missed. Some evolved mouths wide enough to swallow armored snails. Others generated thick lips to yank worms from rocks. One diabolical coven acquired teeth like spears, then skewered its rivals' eyeballs and swallowed them like cocktail onions. In the geologic blink of twelve thousand years, what had begun as a small group of carbon copies became 200 separate species …a carnival of diversity (Sturmbauer & Meyer, 1992; Smith & Layton, 1989; Seehausen, van Alphen, & Witte, 1997).

Not only did 12,000 years suffice to change the genes which gave these fish their body shape and bio-weaponry, that micro-sliver of an eon also provided ample time to rewrite the inborn script of fish psychology. Each new cichlid species was born

[3] Says Neil Howell on his homepage (Howell, 1999), "We have hypothesized that the rate of mtDNA mutation is substantially higher than estimated previously with standard phylogenetic approaches. This hypothesis is being tested with an empirical approach that is free of assumptions and poorly controlled variables."

[4] Lake Nyasa is also known as Lake Malawi.

[5] The traditional view, promoted by Ernst Mayr, is that groups need to be separated by a considerable distance to develop the genetic alterations that lead to speciation. However that model has proven to be incorrect, especially among fish (Mayr, 1970; Tregenza & Butlin, 1999; Morell, 1999).

chromosomally equipped with the hunting or scavenging instincts essential for its new specialty.

Then there is the swarm of bird-biting London mosquitoes which moved into the tunnels of the underground roughly in 1900 when the city's half-built subway system was still occupied primarily by construction crews. Once below the sidewalk, the mosquitoes switched from feeding on feathered fliers to gorging on such delicacies as rats, straphangers, and maintenance workers. By the summer of 1998, the subterranean swarms had changed their genes so thoroughly that they could no longer mate with their distant relatives who lived above the pavement of the street. The pesky Tunnel bugs had taken their genome and gone off on their own, forming an entirely new species (Byrne & Nichols, 1999). In reporting the story, Agence France Presse interviewed Roz Kidman Cox, the editor of *BBC Wildlife Magazine,* the publication responsible for initially breaking the news to a mass audience. Said Kidman Cox, ''The scientists we talked to say the differences between the above and below ground forms are as great as if the species had been separated for thousands of years, not just a century'' (Agence France-Presse, 1998). A mere one hundred years for a major shift in genes is not the painful crawl invoked by champions of Pleistocene fixation. Instead it is the quick-paced hop that Huxley called saltation (Lyons, 1995).

Yet another insect can change its genome twice that fast. It is the soapberry bug, which has renovated its chromosomes to fit new needs at a pace that's dizzying—taking not 100 years but a mere 50. From roughly 1900 to 1980 landscapers and city planners in Florida and in Louisiana produced a bonanza for any insect enterprising enough to go after it. The landscape designers imported new breeds of ornamental trees in an effort to help their clients outdo the neighbors or to spruce up a town's streets. Florida's sprucer-uppers chose the Golden Raintree (*Koelreuteria elegans*), which packaged its seeds in a slender pod whose walls were paper-thin. Louisiana's outdoor decorators went for *Koelreuteria paniculata* and *Cardiospermum halicacabum*, whose seeds were stashed in packets with far thicker casings. Soapberry bugs moved in to mine the new arboreal territories. Each developed genes for a proboscis appropriately sized to seize the opportunities. In Florida where the Raintree pods were easily pierced, the proboscises of soapberry bugs were short. This made for easy sipping, thus saving on resources and on energy. In Louisiana, where seeds of the new eye-pleasing trees were protected by thick rind, soapberry bugs developed a proboscis of a rather different kind—a long, slender drilling cylinder that made the sipping rougher but could bore through sidewalls of a kind far tougher.

Was this really a genetic alteration, or had soapberry bugs whose proboscises were already short or long simply moved large distances, each to the appropriate destination. Genetic testing showed that the specialized bugs had not come from far away, but had evolved from local insects whose proboscises had previously been adapted to harvest the bounty only of the local trees. By checking the dates at which the new greenery had been brought in, researchers could pinpoint the time it had taken to tweak genes for proboscis length. That span turned out to be a breathlessly brief half a century (Carroll, Dingle, & Klassen, 1997; Kelly C. Kissane, personal

communication, May 15, 1998). So a flick of reproductive time can remake genomes in fast-breeding bugs, but what about in larger beings?

2. A switch in size saves lives

In the 1970s, Thomas and Amy Schoener deliberately stranded *Anolis sagrei* lizards from Staniel Cay on numerous smaller islands in the Bahamas, each with a different sort of foliage (Losos, Warheit, & Schoener, 1997). Lizards on islands with stumpy plants adorned with small leaves can operate more efficiently with short hind legs. Lizards on islands whose plants are larger and more luxuriant do better if they have long legs. The oversized limbs come in handy for perching on large leaves, clinging to bulky plant trunks, and achieving a high escape speed when running from local lizard eaters. Washington University biologist Jonathan B. Losos predicted that over time "evolutionary diversification and adaptation" would equip the scattered creatures with the limbs that best fit their needs (Losos, n.d., 1997). But how much time would evolutionary pruning take? Return trips to the islands revealed it had not taken much time at all. The lizards on each island were soon measurably different. Some managed to diverge from their parents' body-type in the twitch of a single decade. That is the equivalent of ten generations—200 years—in human time.

The jury is still out on the contribution made to this transformation by changing genes and the part played by epigenesis and development (Jonathan B. Losos, personal communication, 2/17/01; Losos, 2000). But the verdict is in on the mechanism for another example of instant evolution. In Trinidad there lives a guppy that lends itself beautifully to evolutionary experiments. *Poecilia reticulata* thrives in streams and rivers that flow from mountain sides to the sea. Upstream these colorful fish are faced by one form of natural selector; downstream they are confronted by another. The upstreamers confront the daily dining tastes of *Rivulus hartii*, a predatory fish that prefers to sup on tiny guppy young. Downstream guppies face the appetite of yet another seafood swallower—the *Crenicichla alta*—a connoisseur of large guppy adults. Since uphill guppy eaters prefer their portions small, the guppy genome in the hills must survive by cranking out youngsters too large to look appetizing. And since downhill guppy-gulpers dine exclusively on large guppies, the flatland genome must produce guppy bodies too small to bother swallowing.

How many generations will it take before the preferences of guppy-eaters make the genome of the Poecilia downstream discernably different from the genome of the guppies in the hills? What time actually transpires before selective pressures alter instructions locked in DNA? A clever combination of field and lab experiments has shown that the genetic rewrite takes a mere eleven years—between 30 and 60 generations. In human terms, that is 600–1200 years (Reznick & Endler, 1982; Reznick, Bryga, & Endler, 1990; Reznick, Shaw, Rodd, & Shaw, 1997).

According to University of Washington evolutionary ecologist John N. Thompson, this genetic sprint is par for the course. Says Thompson, "dozens" of genetic transmutations have been known to take place in a matter of mere decades

(Thompson, 1999, p. 2117). Thompson backs up his claims with rather startling facts:

- "Gene-for-gene coevolution in wild flax and flax rust in Australia has produced large changes in allele frequencies within and among populations over just the past decade alone
- "The frequency of clones in *Potamopyrgus antipodarum* snails within a single lake in New Zealand has changed within the past decade through time-lagged selection imposed by a major trematode parasite.
- "The introduction of myxoma virus into Australia as a biological control agent against rabbits resulted in rapid evolution toward decreased virulence within only a few years."(Thompson, 1999, p. 2117)

Thompson explains that one cause of swift genetic change is the sort of race in which one species has to keep pace with its enemies and ecological partners. And lizard expert Jonathan Losos adds that, "If colonizing populations are displaced into an environment that is often very different from that of their source, they are particularly likely to diverge evolutionarily." (Losos, n.d., 1997, p. 70). What is more, writes Losos, the greater the difference in habitat, "the greater the magnitude of differentiation".

3. It is time to eat the neighbors

Both these spurs to genetic speed—environmental change and the need to stay abreast of enemies and ecological allies—were at work in the post-glacial paradise of the Near East. It is difficult to find a human habitat more strikingly different from those which came before than that created by the city. It is also hard to find an environment in which the race against the neighbors could have been swifter. Times were turbulent during the Pleistocene, and there is evidence that Neolithic tribes were subject to attack by murderous rivals (Gibbons, 1997). A bewildering variety of proto-hominids lived, for example, in Northern Spain's Atapuerca 800,000 years ago. We know little about their way of life, but the clues to their way of death indicate that they may have been carved and eaten by whatever fellow humans did to them (Gibbons, 1997). Neanderthals were not the gentle hominids pictured in the novels of Jean Auel. One hundred twenty to eighty thousand years ago, some apparently lived on a diet of red deer—and of other Neanderthals (Defleur, White, Valensi, Slimak, & Crégut-Bonnoure, 1999). That was a long time ago. But 100,000 years later the Neolithic Anasazi, the Aztecs, and the late Stone Age occupants of Fiji were still munching on the members of enemy tribes. (This gives the old song "Love Me Tender" an entirely new meaning.)

There is no sign of this cannibalism in the Near East—but its mere existence is testament to the lack of interhominid peace. During the late Pleistocene, men attained the ability to attack each other with much more than just the stone axe, the

spear (Thieme, 1997), and ravenous teeth.[6] Reports military historian Arther Ferrill, the bow may have been invented as long as 50,000 years ago, as was an even more formidable weapon, the sling. Bows "more than doubled the range of a spear," and arrows were far more portable than the spear had been. But slings such as those we see in nightly news reports of Palestinian street demonstrations trumped the bow's advantages handily. They had greater range and accuracy than arrows, and could be more deadly, even smashing through armor. Ferrill has no doubt that these weapons, along with the dagger and the mace, were used by groups of late Stone Age humans to assault the neighbors, and to do so with grim regularity. He says:

> In prehistoric times man was a hunter and a killer of other men. The killer instinct in the prehistoric male is clearly attested by archaeology in fortifications, weapons, cave paintings, and skeletal remains. … Neolithic cave paintings show warriors forming a line, firing on command, and marching in column behind a leader who was wearing a distinctive uniform that distinguished him from the rest of his troops. … [In the Egyptian site known as 'cemetery 117,' which was actively used from 12,000 to 4500 BC] nearly half of the fifty-nine skeletons show signs of violent deaths inflicted by small flake points (microliths), probably arrowheads. Some of the dead suffered from multiple wounds, and points were discovered in the sphenoid bones in two skulls, suggesting that the victims were shot under the lower jaw, probably as they writhed in pain on their backs. A young adult female had twenty-one stone artifacts in her body (Ferrill, 1990).

> Late Ice Age tribes had depended on state-of-the-art wooden ramparts to ward off murderous attacks (Johnson & Earle, 1987). But once the glaciers had peeled back and left an unbelievable garden of edible plants and equally delectable animals on the Eden-like plains East of the Mediterranean and the Aegean Sea, men and women presumably had the spare time to think up a more ingenious form of defense. The first great leap forward appeared in the form of Jericho, a city conceived and built a full 10,000 years ago when most humans were still living in huts and caves. Jericho's advances in military technology were light years ahead of anything that had come before. The city's mortarless boulder bastions, were 6.5 feet thick and four times the height of a Neolithic man. They were surrounded by a trench nine feet deep and 27 feet wide guarded by watchtowers an unbelievable three stories high (Kenyon, 1960; Singh, 1974; Ussishkin, 1989). Evolution works by weeding out weakness and favoring strength. A city with a wall like this gained a titanic edge in the Stone Age arms race.

How Deadly Was Junk Food?

Which brings us back to the words of biologist Jonathan Losos: "If colonizing populations are displaced into an environment that is often very different from that of their source, they are particularly likely to diverge evolutionarily." The

[6] Valerius Geist believes strongly that teeth were among the weapons humans used to attack each other until fairly recent times. See his Life Strategies. Human Evolution, Environmental Design: Toward a Biological Theory of Health. New York: Springer, 1978.

environment of Jericho was very different indeed. Unlike previous fortifications, the city's walls were apparently not built to cut off and protect the members of one tribe. On the contrary, scholars who have studied the place claim that Jericho was constructed to attract strange foreigners and other passersby (Gibson, 1973). The city was an oasis designed to provide water and shelter to a steady flow of traders.

Trade was also a major raison d'être for another city hundreds of miles north on the Anatolian plains, a town of roughly 60,000 inhabitants that has left highly instructive remains. This was Catal Huyuk, a mass of low-slung apartment buildings that came to life roughly 8000 years ago (Mellaart, 1967). Which brings us to another evolutionary argument. Those who regard agriculture and modernity as the source of all human woes have frequently contended that cities did not confer selective advantages, instead they were selective liabilities. Say the naysayers of the polis, dependence on single-crop diets and the crowding of urban life produced everything from plague and dental cavities to a dramatically shortened life (Harlan, 1995; Baggett, 1999).[7] Cities, they say did not breed a new kind of human being, instead it bred its citizens out. Towns lost inhabitant so quickly to disease that they constantly needed to replenish their population with newcomers from the countryside (Thomas, 1983). Hence natural selection favored rural types reproductively but turned thumbs down on those lured by the high jinks of the city.

But late Stone Age city dwellers were not limited to murderous diets of carbohydrates. Early cities like Jericho and Catal Huyuk were apparently *not* based on the new trick of planting yourself in one spot and poking seeds into the ground, then waiting until they sprouted and digging up the edible bulbs or lopping off the starchy tops. Nor were the first towns based on domesticating the wild game that wandered on the grasslands close at hand. Evidence suggests that the new cities were founded on hunting and gathering, but without the old-fashioned wandering. Urban centers like Catal Huyuk and Jericho initially took their nourishment from a surrounding overflow of wild grain and game spiced with the gastronomic joys provided by the era's booming trade.

[7] Because Baggett's 1995 paper sums up a standardized point of view so nicely, let me quote from it at length: "Perhaps no other event has had a greater impact on humanity's health than the so called Neolithic Revolution. This gradual shift to cultivation occurred at different times for different places, usually between 5000 and 10,000 years BP (Larsen, 1984). Even today man has to always find ways to maximize his crop yield in order to keep up with the ever growing population. For hundreds of thousands of years man had been a nomadic hunter and gatherer. His diet, laden with protein and energy rich foods had enabled him to survive and to evolve into a healthy, lean form. By the end of the last ice age man had moved into every inhabitable part of the planet (Kiple, 1997). It was perhaps the decline of resources coupled with the growing population that prompted some peoples to start cultivating primary food sources. Most infectious diseases can now be traced back to this time when man first began to aggregate in large numbers (McKeown, 1976). We must remember that for essentially all of our existence as humans, hunting and gathering had been our mode of subsistence (Armelagos & McArdle, 1975). The fact that our genetic makeup had adapted to this way of life would have drastic consequences when man shifted to more of a horticultural subsistence (Relethford, 1994). Recent archaeological evidence sheds light on the possibility that the Neolithic Revolution may have been a backwards tumble in our evolution…." On the other side of the issue, several studies have questioned the idea that hunters and gatherers were splendidly nourished as sheer romantic distortion (Alchon, 1997; Wahlqvist, 1992).

Dining in these Stone Age cities was very rich indeed. Fourteen different kinds of food nourished the residents of Catal Huyuk 8500 years ago. The standard groceries ranged from meat and cereals to berries and nuts (Mellaart, 1967). This means the citizens were *better* nourished than tribal hunter-gatherers. One of the main urban staples was red deer, whose herds were so abundant that the reliability of their presence is strongly indicated by both the kitchen middens and the elaborate murals daubed on the walls of Catal Huyuk's standardized, one-plan-fits-all, three-room flats (Mellaart, 1967). A huge percentage of those paintings celebrate the joys hunting parties of men took in bringing down does, fawns, and bucks with arrow and bow. Archaeological remains also indicate the many non-culinary ways in which trade boosted the quality of life in Catal Huyuk dramatically. To quote from *Global Brain* (Bloom, 2000, p. 106):

> The fir from which were carved the elegant adornments gracing sacred altars and the best homes came from the Taurus mountains, as did epicurean delicacies like almonds, pistachio, apples, acorns (good not only for feed but as raw material for leather tanning chemicals and for yogurt making), and berries like juniper and the wine makers' favorite, hackberry. Other mountains closer by provided green-stone, limestone and volcanic rock. Catal Huyuk's alabaster and calcite came from Kayseri, and its creamy white marble from lands far to the west. Its cinnabar was imported from Sizma, and its shells from Mediterranean beaches many miles and mountain ranges to the south. Salt, one of the greatest lacers of distant cultures into nets of trade, came from Ihcapmar, whose industry was based on the mineral gifts of a nearby brackish lake.

The numerous sources from which the citizens of Catal Huyuk purchased their delicacies and building materials gives a rough idea of the number of other towns built around trade. More important, it indicates how much better housed were the members of Catal Huyuk than those who still lived in the old tribal ways. Cities provided protection from cold, rain, and, according to the anthropologists studying the sites, even from natural disaster. Archaeological reasoning says that because of the variety of their resources and of their specialist's abilities, towns could recover from flood or earthquake far more rapidly than tribes still following herds of reindeer or guarding a pass through which other migratory animals flowed.

Urban advantages were so numerous that archaeological remains demonstrate the following fact with overwhelming clarity: tribe after tribe deserted its previous home to migrate en masse into the cities (Gibson, 1973), swelling their population and adding to their diversity.

My admittedly group-oriented theory of evolution—whose model was introduced in my previous book, *The Lucifer Principle: a scientific expedition into the forces of history* (Bloom, 1995), and is amplified significantly in my new volume, *Global Brain* (Bloom, 2000)—places a premium on the potential phylogenetic effects of inter-group tournaments—battles between tribes, city states, nations, and nearly every other form of social gang. Urban populations have been winning battles, establishing empires, and subjugating country folk for ten thousand years now. The natural

selection that winnows social entities has favored city dwellers so powerfully that "indigenous" tribal folk are now on the endangered cultures list. Their hunter-gatherer mode of organization has been tested and has proven wanting. The real irony is that today hunter-gatherers are being "saved" by the surplus time and energy city life grants to its intellectual elites. Only these highly-educated beneficiaries of the interurban weave have sufficient resources to mount the crusades that currently aim to keep failed societies alive.

Meanwhile 27 million people, many of whom have chosen to escape one of their country's 48 surviving tribes (Mendoza Grado & Salvador, n.d.), are gathered in one town alone—Mexico City. They have managed to outbreed and far outlive their very distant hunting-gathering relatives still barely clinging to the ancient ways of life along the banks of the Amazon River and the Orinoco. True, many live in shanties and send their children out to gather food and other necessities from garbage piles we see as a living hell. But in hunter-gatherer terms, these trash heaps are a treasure trove. Yes, I am saying that even a city's scraps can provide a more nourishing and reliable source of food than natural, organic fare tracked down in the wilderness. Primatologist Shirley Strum's baboons managed to demonstrate this fact. The Pumphouse Gang of baboons Strum studied for years in Kenya eventually broke up into several factions. One splinter group stuck to the good old hunter-gatherer ways—digging in almost-impossibly hard soil to pull wild bulbs from the ground and occasionally eating meat when they could bring a young gazelle or other animal down. Another coterie moseyed over to a nearby army barracks and rummaged for food in the place's large garbage dump. Females in the band that stuck to grubbing for all-natural groceries were only able to produce new infants every eighteen months and showed the scruffy signs of marginal health. But the breakaway young Turks who learned to find their sustenance in the military garbage dump grew large and muscular. When battle came it was usually they who attacked. Because they were well nourished and well rested, they had the upper hand. Meanwhile their females could birth new babies at mere twelve-month intervals, a remarkable reproductive luxury. When Strum's vets subjected the garbage pickers and the ground-scrabbling traditionalists to medical tests, the health of the rubbish-relishers was so robust it made the physical fitness of those who had stuck to a natural diet seem pathetic at the very best (Strum, 1987).

Historical surveys of health among Native Americans in the days before Columbus arrived indicate that the hunter-gatherer life has not been any kinder to humans than it has been to baboons. Biological historian Suzanne Austin Alchon (1997) reports that among New World hunter-gatherers:

> Life expectancies at birth were short… from 16 to 22 years for males and 14 to 18 years for females…. This meant that few lived long enough to develop chronic, degenerative diseases associated with aging…. At least 40 percent of all children died by age 5. Complications due to childbirth were a leading cause of death among women. Males, on the other hand, were more likely to sustain traumatic injuries either as a result of violence or accident…. 'Cannibalism, infanticide, sacrifice, geronticide, head-hunting, and other forms of warfare,' was common in

> many hunter-gatherer societies. … Among the diseases common to hunter-gatherer populations…[were] bacterial and parasitic infections such as shigellosis, salmonellosis, tapeworms, hookworms, whipworms, and pin worms,… helminthic infections such as tapeworms,…bacterial diseases, staphylococcal and streptococcal… amebiasis, giardiasis, and toxoplasmosis, all protozoan infections… New World leishmaniasis and American trypanosomiasis, or Chagas' disease…New World spotted fever…bartonellosis, or Carrion's disease, transmitted by sandflies, …other spirochetal diseases, leptospirosis and two types of relapsing fever…anemia, meningitis, or hemorrhaging …[and] endemic relapsing fever [whose] louse-borne epidemic variety…could produce mortality rates of up to 50 percent.

One result: among "small, mobile populations …most individuals were under the age of 20." Another: "In spite of poor nutrition and rising rates of infection, sedentary populations throughout the Americas expanded over time…the availability of corn pap allowed mothers to wean their children at an earlier age, thus decreasing the time between birth intervals. This allowed women to bear more children over the course of their reproductive lives." In other words, the sedentary New World farmers and the city dwellers they fed passed the ultimate evolutionary test. They outbred their wandering tribal neighbors and subjugated them militarily.

As the history of the Olmec, Toltec, Maya, Inca, and Aztec attest, in the post-Jericho world even tillers of the soil would be drawn into the city's sway, altering their crops and ways of life to fit a sprawling metro-based economy. Or, to put it differently, the rise of the city radically changed the playing field even for those who resolutely planted themselves in the distant countryside. And Darwin tells us it is this sort of social makeover whose pressures do the most to pick and choose new crops of genes.[8]

4. Milking genes for all they are worth

Human genetic updates snap into place far more rapidly than we think. Here is another tidbit from the pages of *Global Brain*:

> Behold the refinement of the LA gene which confers the ability to digest milk on adults. Some people, notably those of Northern Europe,[9] have it (Pringle, 1997; Mallory, 1989). Others–like East Asians and Polynesians–don't. It's particularly handy in wintry climes, where the sun frequently refuses to reveal enough of its radiance to generate Vitamin D in human skin. This is a deficiency which cow's

[8] "…the most important of all causes of organic change is one which is almost independent of altered and perhaps suddenly altered physical conditions, namely, the mutual relation of organism to organism…." (Darwin, 1996).

[9] The Norsemen of the Middle Ages, for example, based their society on dairy farming, as did their Indo-European cousins, the Brahmins of India. Both the Brahmins and the Norse were apparently remnants of early Indo-European conquering expeditions from the steppes north of the Black Sea. And both outlawed killing dairy cattle.

> milk neatly cancels out (de Landa, 1997; Durham, 1991). However humans… probably didn't domesticate animals from which they could derive dairy drinks until after the first cities were founded. Which means the gene for adult milkshake tolerance did not appear until well after the walls of Jericho were erected and *Bos taurus* [the nine-foot-tall wild bull from which most domesticated cattle descend] was taught to toe the line. Other genes have arisen during this geological wink of time.[10] One is the sickle cell anemia gene which a mere 2000 years ago (Purves & Orians, 1987) began protecting black Africans against malaria (Wiesenfeld, 1967).[11] Still more are found in the immune shields which defended the European conquerors of the Americas from scourges like measles and smallpox. This heritage of disease resistance seems to have begun in the last five thousand years or less and developed to its fullest just within the last millennium. One clue to the immunological recency: measles is thought to have jumped to humans from the rinderpest of domesticated cattle.[12] It was the dense-packed urban environment which turned it to a killer.[13] In the grisly manner evolution favors, the measles virus massacred those in European cities who had no genetic resistance and left only the fortunates whose genes were able to adjust the immune system to mount an appropriate defense. These protective genes then grew robust within the following generations, making a profound mark on the face of history. The genetic acquisition of immunity was the greatest weapon of the Conquistadors and colonialists, who wiped out an estimated seventy million Native Americans with the unseen weapons of their germs (McNeill, 1998; Diamond, 1997; de Landa, 1997). (Bloom, 2000, p. 114)

Other selective pressures for biological change have run rampant since the days when men first invented the temptation of the city. Most of these pressures are of the sort most likely to shape brain physiology and lead to the creation of "mental modules" oriented toward large-scale social integration. The slice of mankind that pioneered the use of cities in the late Stone Age steeped itself in an urban environment for a good 5000 years before the more famous cities like Ur, Babylon, and Thebes kicked off the later phases of the metropolitan experience. During that pre-Ur stage, the remains of Catal Huyuk make it clear that social differentiation was strong. It appears that wealth was shuttled massively toward those who

[10] For a review of many post-agricultural and post-urban genetic adaptations in humans, including those involving such basics as skull shape and the configuration of teeth, see: Geist (1978, pp. 388–401).

[11] Several groups of genetic researchers have attempted to establish a far older date for the evolution of sickle-cell anemia. However even Stine, Dover, Zhu, and Smith (1992, p. 336) who championed an ancient origin for the sickle-cell gene, acknowledge that its appearance is "usually attributed to recent…mutations".

[12] Measles is caused by a close relative of the rinderpest-producing paramyxovirus (genus Morbillivirus). A second close relation of the paramyxovirus appears in another evolutionarily-recent human companion: the dog. Here it manifests itself as distemper.

[13] We tend to think of measles as a relatively harmless disease of childhood. However measles produces a sub-illness (subacute sclerosing panencephalitis) that attacks the nervous system, leading to a deterioration of mental abilities, a loss of control of the body's muscles, and a crumbling of the ability to speak. This state ends six to nine months later in blindness, dementia, stupor, and death.

specialized in the perpetuation and regeneration of large-scale social dynamics. Priests, for example, are specialists in social cohesion. The work of anthropologist Mary Douglas hints that religious rituals may be practice for the routines that pin together a society (Douglas, 1982). Rituals inculcate obedience to authority, and act as calisthenics for the sort of simultaneous, coordinated activities—complete with selfless sacrifice—which make massive social structures tick. Confucius would have agreed. To him, the constant exercise of ritual was an indispensable social need. Try thinking of it this way: civility is a set of habits, habits of cooperation and habits of self-restraint. To attain these civilized disciplines, one needs a strong prefrontal cortex—home of the executive functions that rein our more chaotic impulses in. One also needs practice—practice repeated nearly every day. Regular rehearsal keeps the habits of self-control vigorously alive. Religious rituals are calisthenics for the habits indispensable to large-scale social enterprise.

Religion also keeps our ancestors chorusing inside of us, inculcating wisdom garnered long before we were born. It links us to the database of generations which have come before. Supercomputers of the late '90s pulled off superhuman feats with a mere dozen processing units hooked up as a team. If a group of 50 humans makes up its mind by parallel processing, that is 50 processors in the neural net at any given time. But add the memory stores of 50 generations, and you have plugged in vestiges of output from 24,950 modules more.

Ancestor worship and respect for ancient authority are among the few things that separate man from beasts. They link us in a chain of wisdom that transcends the centuries. In Catal Huyuk, those who ran the rituals and vivified the myths behind them were the city's priests. So heavily did Catal Huyuk rely on the social glue of priestly ritual that one room in every three was a holy sanctuary. For their services priests were given larger living spaces, more generous allotments of food, and numerous other luxuries. If disaster struck, priests were among the best placed to survive. So were other experts in social connectivity—political leaders like kings, judges, and military chiefs able to settle disagreements with a minimum of friction, to boost consensus, to give men confidence in times that made them tremble, to advance a city's interests, and to help it dodge catastrophe. Merchants tied a city's market to the sources of the goods that satisfied the populace's hungers for basics and for luxuries. These wheeler-dealers pulled together webs of commerce whose furthest ends were hundreds, and later thousands, of miles away. (Catal Huyuk's lapis lazuli came 1500 miles from southern Russia.)

The rich of neolithic cities were the masters of human synapsing. When times turned mean and the deprived were faced with death, the rich were those most likely to survive. Their progeny were blessed with the ability to win the finest mates and to make sure that, in their turn, their children thrived. A city favored those who mastered it. It gave a reproductive edge to those whose genes had helped them plait the social weave. And it favored good followers as well, those able to tame their "primitive" instincts and to demonstrate civility. In times of famine or of drought when the poor curled up in the streets and died, those who led or who obeyed were those most likely to remain alive.

The form of disaster that winnows phenotypes struck cities over and over again. It struck in the form of war—a variety of misfortune that would inspire humans to create offensive weapons and clever stratagems able to undo the invincibility of a rival city's bastions. Jericho would tumble (literally—the city's walls collapsed a total of seven times) and the first metropolis of all would become a wasteland for thousands of years while rival cities thrived. The same fate would befall the early cities of the Indus Valley's Harappan civilization. To the best and most cleverly organized went the spoils—one of which included the continued power to be fruitful and multiply. Thus obedience, cleverness, and organizational creativity thrived. It was literally bred in to the post-Neolithic form of *Homo sapiens*.

Then there were the post-agricultural plagues that continued to decimate populations from Biblical times through Athens' glory days, the height of the Renaissance and the Age of Reason, on up to the influenza pandemic of 1919. In these, the rich outlasted the poor. As Boccaccio demonstrated in *The Decameron*, when others were falling in the streets, the wealthy escaped the cities' ills by high-tailing it to their fancy country retreats. In some cases the rich even benefitted from a scourge, as did the founder of the Krupp fortune, a wealthy burgher during the Black Death who bought up scads of homes and farms left vacant by plague-eradicated families. In normal time these buildings and their fields would have cost a fortune. But in the wake of the bubonic curse they were literally available for pennies. Krupp's legacy (and progeny) prosper off his callous canniness to this very day (Manchester, 1968). But above all, it was, as I said, those who had mastered the art of social integration who were privileged to protect themselves through superior nourishment, housing, and other services from the probability of death. These included statesmen (masters of such cohesive skills as horse-trading, persuasion, and coalition building), warrior-heroes-turned leaders (masters of survival in intergroup tournaments), and wealthy merchants (knitters of intergroup links).

Plagues came over and over again. So did war. Each ran humanity through a selective sieve, culling out the socially unskilled from those who had mastered the large scale urban environment. There have been enormous disputes over the reasons for genetic change in Europe during the post-Neolithic age. Between them, investigators like Ammerman, Cavalli-Sforza, Renfrew, Barbujani, Jacquez, Ligi, Calafell, Bertranpetit, Derish, Sokal, Moral, Marogna, Salis, Succa, Vona, Piazza, Cappello, Olivetti, and Rendine have subjected nearly a thousand different European alleles to scrutiny. But one thing all the disputants agree on is that change has occurred genetically, and that it is happened massively (Pluciennik, 1996). Would some mental modules be favored and others suppressed by 500 generations of this post-urban process? I suspect the answer would be yes. The mental twists most likely to have been blessed were those for living in the city.

5. Uncited Reference

Cosmides and Tooby (1997).

References

Agence France-Presse (1998). Report claims London underground home to new species of mosquito. Author. August 25, Retrieved February 11, 2001, from the World Wide Web: http://www.nando-search.com/newsroom/ntn/health/082598/health2_27_340_noframes.html.

Alchon, S. A. (1997). The great killers in Precolumbian America: A hemispheric perspective. *Latin American Population History Bulletin*. Number 27. Department of History, University of Minnesota. Retrieved February 23, 2001, from the World Wide Web: http://www.hist.umn.edu/~rmccaa/laphb/27fall97/laphb27a.htm.

Baggett, K. (1999). The neolithic revolution and the de-evolution of health. Tuscaloosa, AL: Department of Anthropology, The University of Alabama. March 3, Retrieved February 22, 2001, from the World Wide Web: http://www.as.ua.edu/ant/bindon/ant475/Papers/baggett2.html.

Barash, D. P. (1977). *Sociobiology and behavior*. New York: Elsevier Scientific Publishing Company.

Barash, D. P. (1979). *The whisperings within: Evolution and the origin of human nature*. New York: Penguin Books.

Barash, D. P. (1986). *The hare and the tortoise: Culture, biology, and human nature*. New York: Viking.

Barash, D. P., & Lipton, J. E. (1985). *The caveman and the bomb: Human nature, evolution, and nuclear war*. NY: McGraw Hill.

Barkow, J. H., Cosmides, L., & Tooby, J., (Eds.). (1992). *The adapted mind: Evolutionary psychology and the generation of culture*. New York: Oxford University Press.

Bloom, H. (1995). *The Lucifer principle: A scientific expedition into the forces of history*. New York: Atlantic Monthly Press.

Bloom, H. (2000). *Global brain: The evolution of mass mind from the big bang to the 21st century*. New York: Wiley.

Bower, B. (1999). DNAs evolutionary dilemma. *Science News*, *155*(6), 89.

Brown Jr., W. L., & Wilson, E. O. (1956). Character cisplacement. *Systematic Zoology*, *5*(2), 49–8964.

Byrne K., & Nichols, R.A. (1999). *Culex pipiens* in London underground tunnels: Differentiation between surface and subterranean populations. *Heredity*, *82*(1) Pt 1: 7–15.

Carroll, S. P., Dingle, H., & Klassen, S. P. (1997). Genetic differentiation of fitness-associated traits among rapidly evolving populations of soapberry bug. *Evolution*, *51*(4), 1182–1188.

CNN/Time Interactive (1997). Unabomb trial: The victims. Author. Retrieved February 10, 2001, from the World Wide Web: http://www.cnn.com/SPECIALS/1997/unabomb/victims/index.html.

Cosmides, L., & Tooby, J. (1997). Evolutionary psychology: A primer. Santa Barbara: Center for Evolutionary Psychology, University of California. Retrieved June 1999 from the World Wide Web: http://www.clark.net/pub/ogas/evolution/EVPSYCH_primer.htm.

Darwin, C. (1996). On the origin of species by means of natural selection, or the preservation of favoured races in the struggle for life. Library of the future CD-Rom (4th ed.). Ver. 5.0. Irvine, CA: World Library, Inc.

Defleur, A., White, T., Valensi, P., Slimak, L., & Crégut-Bonnoure, E. (1999). Neanderthal cannibalism at Moula-Guercy, Ardeche, France. *Science*, *286*, 128–131.

de Landa, M. (1997). *A thousand years of nonlinear history*. New York: Zone Books.

Diamond, J. (1997). *Guns, germs, and steel: The fates of human societies*. New York: W.W. Norton.

Douglas, M. (1982). *Natural symbols: Explorations in cosmology*. New York: Pantheon Books.

Durham, W. H. (1991). *Coevolution: Genes, culture, and human diversity*. Stanford, CA: Stanford University Press.

Endler, J. A. (1986). *Natural selection in the wild*. Princeton: Princeton University Press.

Ferrill, A. (1990). Neolithic warfare—The second-oldest profession. *MHQ: The Quarterly Journal of Military History*. Fall 1990 3 (1). Retrieved February 20, 2001 from the World Wide Web: http://eserver.org/history/neolithic-war.txt.

Geist, V. (1978). *Life strategies, human evolution, environmental design: Toward a biological theory of health*. New York: Springer.

Gibbons, A. (1996). On the many origins of species. *Science*, *273*, 1496–1499a.

Gibbons, A. (1997). Archaeologists rediscover cannibals. *Science*, *277*, 635–637.

Gibson, M. (1973). Population shift and the rise of Mesopotamian civilisation. In C. Renfrew (Ed.), *The explanation of culture change: Models in prehistory* (pp. 447–463). Pittsburgh: University of Pittsburgh Press.

Grant, B. R., & Grant, P. R. (1989). Natural selection in a population of Darwins finches. *American Naturalist*, *133*, 377–393.

Grant, P. R. (1994). Ecological character displacement. *Science*, *266*, 746–747.

Harlan, J. R. (1995). The living fields: Our agricultural heritage. New York: Cambridge University Press. Retrieved May 12, 2000, from the World Wide Web: http://wcb.ucr.edu/wcb/schools/CNAS/bpsc/agomezpo/1/modules/page42.

Howell, N. (1999). Genetics. Galveston, TX: The University of Texas Medical Branch. February 17, Retrieved February 10, 2001, from the World Wide Web: http://www.hbcg.utmb.edu/faculty/howell/content.html.

Johnson, A. W., & Earle, T. (1987). *The evolution of human societies: From foraging group to agrarian state*. Stanford: Stanford University Press.

Kazcynski, T. (1995). Manifesto. CNN/Time Interactive. Retrieved February 10, 2001, from the World Wide Web: http://www.time.com/time/reports/unabomber/wholemanifesto.html

Kenyon, K. K. (1960). Excavations at Jericho, 1957–58. *Palestine Excavation Quarterly*, *92*, 88–108.

Losos, J. B. (2000). Evolutionary implications of phenotypic plasticity in the hindlimb of the lizard *Anolis sagrei*. *Evolution*, *54*(1), 301–305.

Losos, J. B. (n.d.). Losos, J.B., Warheit, K.I., & Schoener, T.W. (1997). Adaptive differentiation following experimental island colonization in Anolis lizards. *Nature*, *387*, 70–73. Non-Technical Summary. Retrieved February 20, 2001, from the World Wide Web: http://www.biology.wustl.edu/~lososlab/nature97.html.

Losos, J. B., Warheit, K. I., & Schoener, T. W. (1997). Adaptive differentiation following experimental island colonization in Anolis lizards. *Nature*, *387*, 70–73.

Lyons, S. L. (1995). The origins of T.H. Huxleys saltationism: History in Darwins shadow. *Journal of the History of Biology*, *28*, 463–494.

Mallory, J. P. (1989). *In search of the Indo-Europeans: Language, archaeology, and myth*. New York: Thames and Hudson.

Manchester, W. R. (1968). *The arms of Krupp, 1587–1968*. Boston: Little, Brown.

Mayr, E. (1970). *Populations, species, and evolution*. Cambridge, MA: Harvard University Press.

McNeill, W. H. (1998). *Plagues and peoples*. New York: Anchor Books.

Mellaart, J. (1967). *Catal-Huyuk: A Neolithic town in Anatolia*. New York: McGraw-Hill.

Mendoza Grado, V., & Salvador, R. (n.d.). What is the Indian population of Mexico? *Culture and society of Mexico*. Ames, Iowa: Iowa State University. Retrieved February 23, 2001, from the World Wide Web: http://www.public.iastate.edu/~rjsalvad/scmfaq/indpop.html.

Morell, V. (1999). Ecology returns to speciation studies. *Science*, *284*, 2106–2108.

Morton, T. (2000). The descent of man. Episode 2: Stone age minds in modern skulls. Sydney: Australian Broadcasting Corporation. Retrieved February 10, 2001 from the World Wide Web: http://www.abc.net.au/science/descent/trans2.htm.

Nachman, M. W., Brown, W. M., Stoneking, M., & Aquadro, C. F. (1996). Nonneutral mitochondrial DNA variation in humans and chimpanzees. *Genetics*, *142*, 953–963.

Nuclear Age Peace Foundation (1998, May 5). Countries with nuclear weapons capability. Santa Barbara, CA: Author. Retrieved May 2000 from the World Wide Web: http://www.napf.org/resources/nuclear_racts.html.

Pluciennik, M. (1996). A perilous but necessary search: Archaeology and European identities. In J. Atkinson, I. Banks, & J. O'Sullivan (Eds.), *Nationalism and archaeology* (pp. 35–58). Glasgow: Cruithne Press. Retrieved February 24, 2001 from the World Wide Web: http://archaelogy.lamp.ac.uk/amarkp/PUBLIST/GLASN1.HTM.

Pringle, H. (1997). Death in Norse Greenland. *Science*, *275*, 924–926.

Purves, W. K., & Orians, G. H. (1987). *Life: The science of biology*.. Sunderland, MA: Sinauer.

Reznick, D. N., Bryga, H., & Endler, J. A. (1990). Experimentally induced life-history evolution in a natural population. *Nature*, *346*, 357–359.

Reznick, D. N., & Endler, J. (1982). The impact of predation on life history evolution in Trinidadian guppies (*Poecilia reticulata*). *Evolution*, *36*, 160–177.

Reznick, D. N., Shaw, F. H., Rodd, F. H., & Shaw, R. G. (1997). Evaluation of the rate of evolution in natural populations of guppies (*Poecilia reticulata*). *Science*, *275*, 1934–1937.

Schluter, D. (1994). Experimental evidence that competition promotes divergences in adaptive radiation. *Science*, *266*, 798.

Seehausen, O., van Alphen, J. J. M., & Witte, F. (1997). Cichlid fish diversity threatened by eutrophication that curbs sexual selection. *Science*, *277*, 1808–7981810.

Singh, P. (1974). *Neolithic cultures of Western Asia*. New York: Seminar Press.

Smith, M. T., & Layton, R. (1989). Still human after all these years. *The Sciences*, *39*, 10.

Stine, O. C., Dover, G. J., Zhu, D., & Smith, K. D. (1992). The evolution of two west African populations. *Journal of Molecular Evolution*, *34*, 336–344.

Strum, S. C. (1987). *Almost human: A Journey into the world of Baboons*. New York: Random House.

Sturmbauer, C., & Meyer, A. (1992). Genetic divergence, speciation and morphological stasis in a lineage of African cichlid fishes. *Nature*, *358*, 578–581.

Thieme, H. (1997). Lower Paleolithic hunting spears from Germany. *Nature*, *385*, 807–810.

Thomas, K. (1983). *Man and the natural world: A history of the modern sensibility*. New York: Pantheon Books.

Thompson, J. N. (1999). The evolution of species interactions. *Science*, *284*, 2116–2118.

Tregenza, T., & Butlin, R. K. (1999). Speciation without isolation. *Nature*, *400*, 311–312.

Ussishkin, D. (1989). Notes on the fortifications of the Middle Bronze II Period at Jericho and Shechem. *Bulletin of the American Schools of Oriental Research*, *276*, 29–54.

Wahlqvist, M. L. (1992). Critical nutrition events in human history. *Asia Pacific Journal of Clinical Nutrition*, *1*, 101–105.

Weiner, J. (1995). Evolution made visible. *Science*, *267*, 30–33.

Wiesenfeld, S. L. (1967). Sickle-cell trait in human biological and cultural evolution. Development of agriculture causing increased malaria is bound to gene-pool changes causing malaria reduction. *Science*, *157*, 1134–1140.

Wilson, E. O. (1971). *The insect societies*. Cambridge: Harvard University Press.

Wilson, E. O. (1975). *Sociobiology: The new synthesis*.. Cambridge: Harvard University Press.