THE THIRD CHIMPANZEE

The Evolution and Future of the Human Animal

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CHAPTER 14

Accidental Conquerors

SOME OF THE MOST OBVIOUS FEATURES OF OUR DAILY LIVES POSE THE hardest questions for scientists. If you look around you in most locations in the United States or Australia, most of the people you see will be of European ancestry. At the same locations five hundred years ago, everyone without exception would have been an American Indian in the United States, a native (aboriginal) Australian in Australia. Why is it that Europeans came to replace most of the native population of North America and Australia, instead of Indians or native Australians coming to replace most of the original population of Europe?

This question can be rephrased to ask: Why was the ancient rate of technological and political development fastest in Eurasia, slower in the Americas (and in Africa south of the Sahara), and slowest in Australia? For example, in 1492 much of the population of Eurasia used iron tools, had writing and agriculture, had large centralized states with oceangoing ships, and was on the verge of industrialization. The Americas had agriculture, only a few large centralized states, writing in only one area, and no oceangoing ships or iron tools, and they were technologically and politically a few thousand years behind Eurasia. Australia lacked agriculture, writing, states, and ships, was still in a pre-first-contact condition, and used stone tools comparable to ones made over ten thousand years earlier in Eurasia. It was those technological and political differences—not the biological differences determining the outcome of competition among animal populations—that permitted Europeans to expand to other continents.

Nineteenth-century Europeans had a simple, racist answer to such questions. They concluded that they acquired their cultural head start through being inherently more intelligent, and that they therefore had a manifest destiny to conquer, displace, or kill "inferior" peoples. The trouble with this answer is that it is not just loathsome and arrogant, but also wrong. It's obvious that people differ enormously in the knowledge they acquire, depending on their circumstances as they grow up. But no convincing evidence of genetic differences in mental ability among peoples has been found, despite much effort.

Because of this legacy of racist explanations, the whole subject of human differences in level of civilization still reeks of racism. Yet there are obvious reasons why the subject begs to be properly explained. Those technological differences led to great tragedies in the past five hundred years, and their legacies of colonialism and conquest still powerfully shape our world today. Until we can come up with a convincing alternative explanation, the suspicion that racist genetic theories might be true will linger.

In this chapter I'll argue that continental differences in level of civilization arose from geography's effect on the development of our cultural hallmarks, not from human genetics. Continents differed in the resources on which civilization depended—especially in the wild animal and plant species that proved useful for domestication. Continents also differed in the ease with which domesticated species could spread from one area to another. Even today, Americans and Europeans are painfully aware how distant geographical features, like the Persian Gulf or the Isthmus of Panama, affect our lives. But geography and biogeography have been molding human lives even more profoundly for hundreds of thousands of years.

Why do I emphasize plant and animal species? As the biologist J. B. S. Haldane remarked, "Civilization is based, not only on men, but on plants and animals." Agriculture and herding, though they also brought the disadvantages discussed in Chapter 10, still made it possible to feed far more people per square mile of land than could live on the wild foods available in that same area. Storable food surpluses grown by some individuals permitted other individuals to devote themselves to metallurgy, manufacturing, writing—and to serving in full-time professional armies. Domestic animals provided not only meat and milk to feed people, but also wool and hides to clothe people, and power to transport people and goods. Animals also provided power to pull plows and carts, and thus to increase agricultural productivity greatly over that previously attainable by human muscle power alone.

As a result, the world's human population rose from about ten million around 10,000 B.C., when we were all still hunter-gatherers, to over five billion today. Dense populations were prerequisite to the rise of centralized states. Dense populations also promoted the evolution of infectious diseases, to which exposed populations then evolved some resistance but other populations didn't. All these factors determined who colonized and conquered whom. Europeans' conquest of America and Australia was due not to their better genes but to their worse germs (especially smallpox), more advanced technology (including weapons and ships), information storage through writing, and political organization—all stemming ultimately from continental differences in geography.

LET'S START WITH THE DIFFERENCES in domestic animals. By around 4000 B.C. west Eurasia already had its "Big Five" domestic livestock that continue to dominate today: sheep, goats, pigs, cows, and horses. East Asians domesticated four other cattle species that locally replace cows: yaks, water buffalo, gaur, and banteng. As already mentioned, these animals provided food, power, and clothing, while the horse was also of incalculable military value. (It was the tank, the truck, and the jeep of warfare until the nineteenth century.) Why didn't American Indians reap similar benefits by domesticating the corresponding native American mammal species: mountain sheep, mountain goats, peccaries, bison, and tapirs? Why didn't Indians mounted on tapirs, and native Australians mounted on kangaroos, invade and terrorize Eurasia?

The answer is that, even today, it has proved possible to domesticate only a tiny fraction of the world's wild mammal species. This becomes clear when one considers all the attempts that failed. Innumerable species reached the necessary first step of being kept captive as tame pets. In New Guinea villages I routinely find tamed possums and kangaroos, while I saw tamed monkeys and weasels in Amazonian Indian villages. Ancient Egyptians tamed gazelles, antelopes, cranes, and even hyenas and possibly giraffes. Romans were terrorized by the tamed African elephants with which Hannibal crossed the Alps (*not* Asian elephants, the tame elephant species in circuses today).

But all these incipient efforts at domestication failed. Domestication requires not just capturing individual wild animals and taming them, but getting them to breed in captivity and modifying them through selective breeding so as to be more useful to us. Since the domestication of horses around 4000 B.C. and reindeer a few thousand years later, no large European mammal has been added to our repertoire of successful domesticates. Thus, our few modern species of domestic mammals were quickly winnowed from hundreds of others that had been tried and abandoned.

Why have efforts at domesticating most animal species failed? It turns out that a wild animal must possess a whole suite of unusual characteristics for domestication to succeed. First, in most cases it must be a social species living in herds. A herd's subordinate individuals have instinctive submissive behaviors that they display toward dominant individuals, and that they can transfer toward humans. Asian mouflon sheep (the ancestors of domestic sheep) have such behaviors but North American bighorn sheep do not—a crucial difference that prevented Indians from domesticating the latter. Except for cats and ferrets, solitary territorial species have not been domesticated.

Second, species such as gazelles and many deer and antelopes, which instantly take flight at signs of danger instead of standing their ground, prove too nervous to manage. Our failure to domesticate deer is especially striking, since there are few other wild animals with which humans have been so closely associated for tens of thousands of years. Although deer have always been intensively hunted and often tamed, reindeer alone among the world's forty-one deer species were successfully domesticated. Territorial behavior, flight reflexes, or both eliminated the other forty species as candidates. Only reindeer had the necessary tolerance of intruders and gregarious, nonterritorial behavior.

Finally, as zoos often discover to their dismay, captive animals that are docile and healthy may nevertheless refuse to breed in cages. You yourself wouldn't want to carry out a lengthy courtship and copulate under the watchful eyes of others; many animals don't want to either. This problem of getting captive animals to breed has derailed persistent attempts to domesticate some potentially very valuable animals. For example, the finest wool in the world comes from the vicuña, a small camel species native to the Andes. But neither the Incas nor modern ranchers have ever been able to domesticate it, and wool must still be obtained by capturing wild vicuñas. Princes from ancient Assyrian kings to nineteenth-century Indian maharajahs have tamed cheetahs, the world's swiftest land mammals, for hunting. But every prince's cheetah had to be captured from the wild, and not even zoos were able to breed them until 1960.

Collectively, these reasons help explain why Eurasians succeeded in domesticating the Big Five but not other closely related species, and why American Indians did not domesticate bison, peccaries, tapirs, and mountain sheep or goats. The military value of the horse is especially interesting in illustrating what seemingly slight differences make one species uniquely prized, another useless. Horses belong to the order of mammals termed Perissodactyla, which consists of the hoofed mammals with an odd number of toes: horses, tapirs, and rhinoceroses. Of the seventeen living species of Perissodactyla, all four tapirs and all five rhinos, plus five of the eight wild horse species, have never been domesticated. Africans or Indians mounted on rhinos or tapirs would have trampled any European invaders, but it never happened.

A sixth wild horse relative, the wild ass of Africa, gave rise to domestic donkeys, which proved splendid as pack animals but useless as military chargers. The seventh wild horse relative, the onager of western Asia, may have been used to pull wagons for some centuries after 3000 B.C. But all accounts of the onager blast its vile disposition with adjectives like "bad-tempered," "irascible," "unapproachable," "unchangeable," and "inherently intractable." The vicious beasts had to be kept muzzled to prevent them from biting their attendants. When domesticated horses reached the Middle East around 2300 B.C., onagers were finally kicked onto the scrap heap of failed domesticates.

Horses revolutionized warfare in a way that no other animal, not even elephants or camels, ever rivaled. Soon after their domestication, they may have enabled herdsmen speaking the first Indo-European languages to begin the expansion that would eventually stamp their languages on much of the world. A few millennia later, hitched to battle chariots, horses became the unstoppable Sherman tanks of ancient war. After the invention of saddles and stirrups, they enabled Attila the Hun to devastate the Roman Empire, Genghis Khan to conquer an empire from Russia to China, and military kingdoms to arise in West Africa. A few dozen horses helped Cortés and Pizarro, leading only a few hundred Spaniards each, to overthrow the two most populous and advanced New World states, the Aztec and Inca empires. With futile Polish cavalry charges against Hitler's invading armies in September 1939, the military importance of this most universally prized of all domestic animals finally came to an end after six thousand years.

Ironically, relatives of the horses that Cortés and Pizarro rode had formerly been native to the New World. Had those horses survived, Montezuma and Atahualpa might have shattered the conquistadores with cavalry charges of their own. But, in a cruel twist of fate, America's horses had become extinct long before that, along with 80 or 90 percent of the other large animal species of the Americas and Australia. It happened around the time that the first human settlers—ancestors of modern Indians and native Australians—reached those continents. The Americas lost not only their horses but also other potentially domesticable species like large camels, ground sloths, and elephants. Australia and North America ended up with no domesticable mammal species at all, unless Indian dogs were derived from North American wolves. South America was left with only the guinea pig (used for food), alpaca (used for wool), and llama (used as a pack animal, but too small to carry a rider).

As a result, domestic mammals made no contribution to the protein needs of native Australians and Americans except in the Andes, where their contribution was still much slighter than in the Old World. No native American or Australian mammal ever pulled a plough, cart, or war chariot, gave milk, or bore a rider. The civilizations of the New World limped forward on human muscle power alone, while those of the Old World ran on the power of animal muscle, wind, and water.

Scientists still debate whether the prehistoric extinctions of most large American and Australian mammals were due to climatic factors or were caused by the first human settlers themselves. Whichever was the case, the extinctions may have virtually ensured that the descendants of those first settlers would be conquered over ten thousand years later by people from Eurasia and Africa, the continents that retained most of their large mammal species.

Do SIMILAR ARGUMENTS apply to plants? Some parallels jump out immediately. As true of animals, only a tiny fraction of all wild plant species have proved suitable for domestication. For example, plant species in which a single hermaphroditic individual can pollinate itself (like wheat) were domesticated earlier and more easily than cross-pollinated species (like rye). The reason is that self-pollinating varieties are easier to select and then maintain as true strains, since they're not continually mixing with their wild relatives. As another example, although acorns of many oak species were a major food source in prehistoric Europe and North America, no oak has ever been domesticated, perhaps because squirrels remained much better than humans at selecting and planting acorns. For every domesticated plant that we still use today, many others were tried in the past and discarded. (What living American has eaten sumpweed, which Indians in the eastern United States domesticated for its seeds by around 2000 B.C.?).

Such considerations help explain the slow rate of human technological development in Australia. That continent's relative poverty in wild plants appropriate for domestication, as in appropriate wild animals, undoubtedly contributed to the failure of aboriginal Australians to develop agriculture. But it's not so obvious why agriculture in the Americas lagged behind that in the Old World. After all, many food plants now of worldwide importance were domesticated in the New World: corn, potatoes, tomatoes, and squash, to name just a few. The answer to this puzzle requires closer scrutiny of corn, the New World's most important crop.

Corn is a cereal—i.e., a grass with edible starchy seeds, like barley kernels or wheat grains. Cereals still provide most of the calories consumed by the human race. While all civilizations have depended on cereals, different native cereals have been domesticated by different civilizations: e.g., wheat, barley, oats, and rye in the Near East and Europe; rice, foxtail millet, and broomcorn millet in China and southeast Asia; sorghum, pearl millet, and finger millet in sub-Saharan Africa; but only corn in the New World. Soon after Columbus discovered America, corn was taken back to Europe by early explorers and spread around the globe, so that it now exceeds all other crops except wheat in world acreage planted. Why, then, didn't corn enable American Indian civilizations to develop as fast as the Old World civilizations fed by wheat and other cereals?

It turns out that corn was a much bigger pain in the neck to domesticate and grow, and gave an inferior product. Those will be fighting words to all of you who, like me, love hot buttered corn-on-the-cob. Throughout my childhood, I looked forward to late summer as the season to stop at roadside stands and pick out the best-looking fresh ears. Corn is the most important crop in the United States today, worth $22 billion to us and $50 billion to the world. But before you charge me with slander, please hear me out on the differences between corn and other cereals.

The Old World had over a dozen wild grasses that were easy to domesticate and grow. Their large seeds, favored by the Near East's highly seasonal climate, made their value obvious to incipient farmers. They were easy to harvest en masse with a sickle, easy to grind, easy to prepare for cooking, and easy to sow. Another subtle advantage was first recognized by University of Wisconsin botanist Hugh Iltis: we didn't have to figure out for ourselves that they could be stored, since wild rodents in the Near East already made caches of up to sixty pounds of those wild grass seeds.

The Old World grains were already productive in the wild: one can still harvest up to seven hundred pounds of grain per acre from wild wheat growing naturally on hillsides in the Near East. In a few weeks a family could harvest enough to feed itself for a year. Hence even before wheat and barley were domesticated, there were sedentary villages in Palestine that had already invented sickles, mortars and pestles, and storage pits, and that were supporting themselves on wild grains.

Domestication of wheat and barley wasn't a conscious act. It wasn't the case that several hunter-gatherers sat down one day, mourned the extinction of big game animals, discussed which particular wheat plants were best, planted the seeds of those plants, and thereby became farmers the next year. Instead, the process we call plant domestication—the changes in wild plants under cultivation—was an unintended by-product of people's preferring some wild plants over others, and hence accidentally spreading seeds of the preferred plants. In the case of wild cereals, people naturally preferred to harvest those with big seeds, those whose seeds were easy to remove from the seed coverings, and those with firm nonshattering stalks that held all the seeds together. It took only a few mutations, favored by this unconscious human selection, to produce the large-seeded, nonshattering cereal varieties that we refer to as domesticated rather than wild.

By around 8000 B.C., wheat and barley remains from archaeological digs at ancient Near Eastern village sites are beginning to show these changes. The development of bread wheats, other domestic varieties, and intentional sowing soon followed. Gradually, fewer remains of wild foods are found at the sites. By 6000 B.C., crop cultivation had been integrated with animal herding into a complete food-production system in the Near East. For better or worse, people were no longer hunter-gatherers but farmers and herders, en route to being civilized.

Now contrast these relatively straightforward Old World developments with what happened in the New World. Because the parts of the Americas where farming began lacked the Near East's highly seasonal climate, they lacked large-seeded grasses that were already productive in the wild. North American and Mexican Indians did start to domesticate three small-seeded wild grasses—maygrass, little barley, and a wild millet—but these were displaced by the arrival of corn and then of European cereals. Instead, the ancestor of corn was a Mexican wild grass that did have the advantage of big seeds but in other respects hardly seemed like a promising food plant: annual teosinte.

Teosinte ears look so different from corn ears that scientists argued about teosinte's precise role in corn's ancestry till recently, and even now some scientists remain unconvinced. No other crop underwent such drastic changes on domestication as did teosinte. It has only six to twelve kernels per ear, and they are inedible, because they're enclosed in stone-hard cases. One can chew teosinte stalks like sugar cane, as Mexican farmers still do. But no one uses its seeds today, and there is no indication that anyone did prehistorically either.

Hugh Iltis identified the key step in teosinte's becoming useful: a permanent sex change! In teosinte the side branches end in tassels composed of male flowers; in corn they end in female structures, the ears. Although that sounds like a drastic difference, it's really a simple hormonally controlled change that could have been started by a fungus, virus, or change in climate. Once some flowers on the tassel had changed sex to female, they would have produced edible naked grains likely to catch the attention of hungry hunter-gatherers. The tassel's central branch would then have been the beginning of a corncob. Early Mexican archaeological sites have yielded remains of tiny ears, barely an inch and a half long and much like the tiny ears of our Tom Thumb corn variety.

With that abrupt sex change, teosinte (alias corn) was now finally on the road to domestication. However, in contrast to the case with Near Eastern cereals, thousands of years of development still lay ahead before high-yield corns capable of sustaining villages or cities resulted. The final product was still much more difficult for Indian farmers to manage than were the cereals of Old World farmers. Corn ears had to be harvested individually by hand, rather than en masse with a sickle; the cobs had to be shucked; the kernels didn't fall off but had to be scraped or bitten off; and sowing the seeds involved planting them individually, rather than scattering them en masse. And the result was still poorer nutritionally than Old World cereals: lower protein content, deficiencies of nutritionally important amino acids, deficiency of the vitamin niacin (tending to cause the disease pellagra), and need for alkali treatment of the grain to partially overcome these deficiencies.

In short, characteristics of the New World's staple food crop made its potential value much harder to discern in the wild plant, harder to develop by domestication, and harder to extract even after domestication. Much of the lag between New World and Old World civilization may have been due to those peculiarities of one plant.

So FAR, I've discussed geography's biogeographic role in providing the local wild animal and plant species suitable for domestication. But there's another major role of geography that deserves mention. Each civilization has depended not only on its own food plants domesticated locally, but also on other food plants that arrived after having been first domesticated elsewhere. The predominantly north-south axis of the New World made such diffusion of food plants difficult; the predominantly east-west axis of the Old World made it easy (see Figure 6).

Today, we take plant diffusion so much for granted that we seldom stop to think where our foods originated. A typical American or European meal might consist of chicken (of Southeast Asian origin) with corn (from Mexico) or potatoes (from the southern Andes), seasoned with pepper (from India), accompanied by a piece of bread (from Near Eastern wheat) and butter (from Near Eastern cattle), and washed down by a cup of coffee (from Ethiopia). But this diffusion of valued plants and animals didn't begin just in modern times: it has been happening for thousands of years.

Plants and animals spread quickly and easily within a climate zone to which they're already adapted. To spread out of this zone, they have to develop new varieties with different climate tolerances. A glance at the map of the Old World in Figure 6 shows how species could shift long distances without encountering a change of climate. Many of these shifts proved enormously important in launching farming or herding in new areas, or enriching it in old areas. Species

Axes of the Old and New Worlds

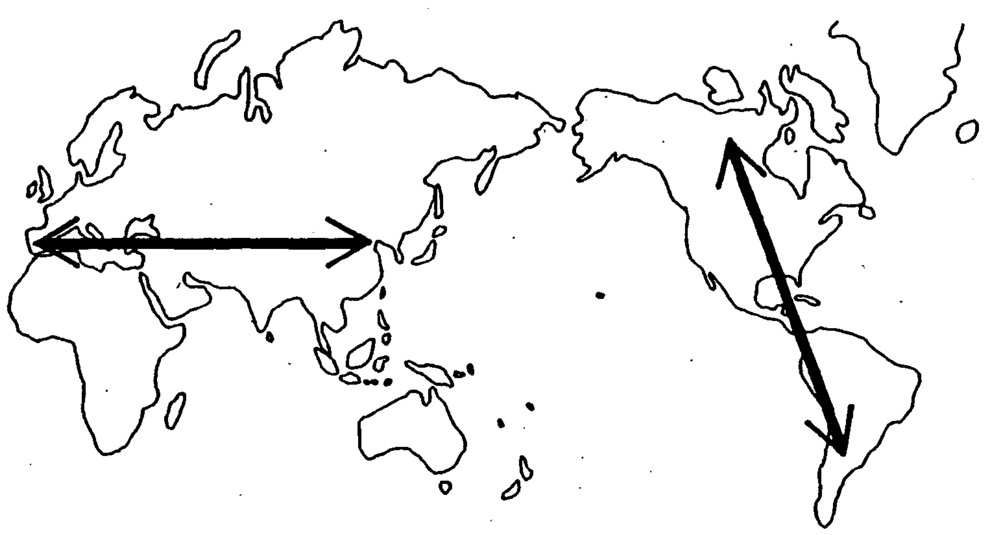

Figure 6.

moved between China, India, the Near East, and Europe without ever leaving temperate latitudes of the northern hemisphere. Ironically, the U.S. patriotic song "America the Beautiful" invokes America's own spacious skies, its amber waves of grain. In reality, the most spacious skies of the northern hemisphere are in the Old World, where amber waves of related grains came to stretch for seven thousand miles from the English Channel to the China Sea.

The ancient Romans were already growing wheat and barley from the Near East, peaches and citrus fruits from China, cucumbers and sesame from India, and hemp and onions from central Asia, along with oats and poppies originating locally in Europe. Horses that spread from the Near East to West Africa revolutionized military tactics there, while sheep and cattle spread down from the highlands of East Africa to launch herding in southern Africa among the Hottentots, who lacked locally domesticated animals of their own. African sorghum and cotton reached India by around 2000 B.C., while bananas and yams from tropical Southeast Asia crossed the Indian Ocean to enrich agriculture in tropical Africa.

In the New World, however, the temperate zone of North America is isolated from the temperate zone of the Andes and southern South America by thousands of miles of tropics, in which temperate-zone species can't survive. As a result, the llama, alpaca, and guinea pig of the Andes never spread in prehistoric times to North America or even to Mexico, which consequently remained without any domestic mammals to carry packs or to produce wool or meat (except for corn-fed edible dogs). Potatoes as well failed to spread from the Andes to Mexico or North America, while sunflowers never spread from North America to the Andes. Many crops that were apparently shared prehistorically between North and South America actually occurred as different varieties or even species in the two continents, suggesting that they were domesticated independently in both areas. This seems true, for instance, of cotton, beans, lima beans, chili peppers, and tobacco. Corn did spread from Mexico to both North and South America, but it evidently wasn't easy, perhaps because of the time it took to develop varieties suited to other latitudes. Not until around A.D. 900—thousands of years after corn had emerged in Mexico—did corn become a staple food in the Mississippi Valley, thereby triggering the belated rise of the mysterious mound-building civilization of the American Midwest.

If the Old and New Worlds had each been rotated ninety degrees about their axes, the spread of crops and domestic animals would have been slower in the Old World, faster in the New World. The rates of rise of civilization would have been correspondingly different. Who knows whether that difference would have sufficed to let Montezuma or Atahualpa invade Europe, despite their lack of horses?

I've argued, then, that continental differences in the rates of rise of civilization weren't an accident caused by a few individual geniuses. They weren't produced by the biological differences determining the outcome of competition among animal populations—e.g., some populations being able to run faster or digest food more efficiently than others. They also weren't the result of average differences among whole peoples in inventiveness; there is no evidence for such differences anyway. Instead, they were determined by biogeography's effect on cultural development. If Europe and Australia had exchanged their human populations twelve thousand years ago, it would have been the former native Australians, transplanted to Europe, who eventually invaded America and Australia from Europe.

Geography sets ground rules for the evolution, both biological and cultural, of all species, including our own. Geography's role in determining our modern political history is even more obvious than its role in determining the rate at which we domesticate plants and animals. From this perspective, it's almost funny to read that half of all American schoolchildren don't know where Panama is, but not at all funny when politicians display comparable ignorance. Among the many notorious examples of disasters brought on by politicians ignorant of geography, two must suffice: the unnatural boundaries drawn on the map of Africa by nineteenth-century European colonial powers, thereby undermining the stability of some modern African states that inherited those borders; and the borders of Eastern Europe drawn at the Treaty of Versailles in 1919 by politicians who knew little of that region, thereby helping fuel World War II.

Geography used to be a required subject in schools and colleges until a few decades ago, when it began to be dropped from many curricula. The mistaken belief arose then that geography consisted of little more than memorizing the names of capital cities. But twenty weeks of geography in the seventh grade isn't enough to teach our future politicians about the effects that maps really have on us. The fax machines and satellite communications that span the globe can't erase the differences among us bred by differences in location. In the long run, and on a broad scale, where we live has contributed heavily to making us who we are.