The Broadest Pattern of Human History

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INTRODUCTION

As world travel developed in recent centuries from 1492 onward, it quickly became obvious that peoples with very different economies, technologies, and political organizations coexisted in the modern world. At one extreme were the large Iron Age states occupying much of Europe, Asia (except Siberia), and North Africa, plus the smaller Iron Age states of West Africa. Comparable in political organization, but lacking in iron technology, were the Inca Empire of the Andes and the Aztec state of Mexico. The range of societies continued through the Neolithic settled chiefdoms of other parts of the Americas and Polynesia, with some of those societies (such as Polynesian Hawaii and the Mississippian civilization of Indian North America) verging on the level of states. The list went on to the Neolithic tribal farming societies of New Guinea and the remainder of the New World and concluded with the hunter-gatherers of the Arctic, Australia, and scattered areas of the Americas, Africa, and Asia.

This snapshot of the diverse world as of 1492 was subsequently illuminated by archaeologists, who obtained in effect a series of snapshots at earlier times. It then became clear that the geographic differences among human societies as of 1492 resulted from differences, extending back over at least 10,000 years, in the dates of first appearance of developments such as stone tool grinding, metallurgy, pottery, and plant and animal domestication. For example, mass production of copper tools, which was beginning to be widespread in the Andes in the centuries before 1492, was already spreading in parts of Eurasia 5,000 years before that. The stone technology of the Tasmanians, when first encountered by literate observers in 1642, was simpler than that of Upper Paleolithic Europe tens of thousands of years earlier.

The collisions among these disparate peoples shaped the modern world through conquest, epidemics, and genocide. These collisions set up reverberations that have still not died down after many centuries and that are being played out in some of the most troubled areas of the world today (such as South Africa and the former Soviet Union).

In the present essay, I shall explore the hypothesis that these differences between human societies resulted not from differences between the peoples themselves, but from effects of environment and geography —that is, from contrasts between the real estate that different peoples inherited. Two caveats are necessary at the outset, since many people may initially consider this topic an unfit one for polite discussion. First, this whole subject stinks of racism, because nineteenth-century Europeans explained the observed geographic differences in complexity of human societies in terms of supposed parallel differences among peoples in their mental abilities. Despite much effort to document these supposed differences, no sound supporting evidence has been forthcoming. Available evidence even supports the reverse conclusion. For example, Alaskan Inuit (Eskimo) children have been reported to score considerably higher on standard "intelligence" tests, such as the Stanford-Binet test, than white Americans, even though the latter might be supposed to have had a big advantage on such tests because of the tests' relationship to formal schooling. Again, my own impression of the many New Guinea peoples with whom I have worked during the past thirty years is that they appear on the average considerably more intelligent than white Americans, though I have no idea whether this impression (if correct) reflects superior human genetics or else effects of more social stimulation in New Guinea societies. Nonetheless, the lingering, even if tacit, assumption that mental differences contribute to the worldwide differences among human societies remains widespread. The persistence of this pernicious wrong assumption would alone be sufficient reason to seek to replace it by a correct and convincing explanation.

I should also make one other point clear at the outset. Although it may be convenient to use the conventional phrase "rise of civilizations" to refer to these global patterns, I am not thereby assuming that Iron Age states are "better" than hunter-gatherer tribes, nor that the abandonment of the hunter-gatherer life-style for iron-based statehood represents "progress," nor that the transition has led to an increase in human happiness. Even if one did attempt to decide which condition was "better," one would have to evaluate a very mixed picture. For example, compared to hunter-gatherers, citizens of modern Westernized states enjoy a longer life-span and lower risk of death by homicide, and also suffer from much less social support from friendships and extended family. Instead, my motivation for investigating these geographic differences in human societies is simply that they cry for explanation, as the broadest pattern of human history.

The differences between the histories of Eurasia, the Americas, sub-Saharan Africa, and Australia are too great to be dismissed as accidents resulting from contributions of individual geniuses or individual societies. When we are dealing with these spatial scales of whole continents and these time scales of tens of thousands of years, there must have been environmental factors, rather than accidents, to account for these differences. Thus, when I talk about "the broadest pattern of human history," I do not expect to contribute anything to answering such questions as why Napoleon rather than his enemies lost the Battle of Waterloo. Instead, I would like to explain questions such as why copper tool manufacture emerged much earlier in the Old World than in the New World and never emerged in Australia.

I shall begin with a brief discussion of human societal variation within Polynesia, to illustrate how large differences among human societies descended from a common ancestral society can be clearly attributed to environmental differences. I shall then turn to one of the most dramatic collisions in recent human history, that between the Inca emperor Atahuallpa and the Spanish con-

quistador Pizarro at the Peruvian town of Cajamarca in 1532, as a starting point for understanding the more general problem of the differences between human development in the Americas and in Eurasia. Next, I shall examine whether the insights derived from that American/Eurasian collision prove useful in understanding the history of subsaharan Africa. Finally, I shall turn to the histories of Native Australia and Tasmania, where the insights derived from the American/Eurasian/African comparisons prove irrelevant, and where additional factors emerge that may also have been significant elsewhere in the world.

Polynesia: A Model for the Influence of Geography on Society

Polynesia provides particularly clear evidence of differences between human societies conditioned by differences in geography. All Polynesian islands, plus some Pacific islands that belong geographically to Melanesia and Micronesia, were settled by descendants of a single ancestral people. They are known archaeologically as the Lapita people, named after the archaeological site on New Caledonia where their pottery was first excavated and described. The Lapita people spread directly from the tropical Bismarck and Solomon Archipelagoes near New Guinea, and ultimately from Indonesia and Southeast Asia. Thus, the recent populations of all Polynesian islands were derived from founding groups bearing essentially the same culture, language, technology (based on stone rather than metal), and kit of domesticated plants and animals. Polynesia offers to the historian the further advantage of a modest time depth: human colonization of Polynesia began around 1600 B.C. and was largely completed by around A.D. 500, except for a few islands (such as New Zealand, the Chathams, and Henderson) settled perhaps as late as A.D. 1000.

To these rather uniform human colonizing stocks, Polynesia presented huge differences in the environment. Polynesian islands range from sub-Antarctic to tropical, and from tiny islets to virtual

continents. Correspondingly, there were huge differences among recent Polynesian societies, before they began to be modified by European influence. These differences among societies are clearly correlated with the geographic differences among Polynesian islands. Thus, Polynesia illustrates how, within a time span much shorter than the span of human occupation on any continent except Antarctica, and with a history devoid of the complications inevitable in multiple human colonization waves bringing varying cultural and social inheritances, geography can cause one people to diversify.

The areas of difference among Polynesian societies include their sources of food, their economic specialization, their social organization, their political organization, and their elaboration of cultural products. As regards food, Polynesians included hunter-gatherers on the Chatham Islands and on New Zealand's South Island, but most Polynesians were farmers. However, Polynesian agriculture varied in intensity, in whether it utilized no or up to three species of domestic animals, in whether it depended on (New Zealand's North Island) or dispensed with (Hawaii) food storage, in the development of irrigation systems, and in the development of aquaculture (unique to Hawaii). Economic organization ranged from societies where each household produced what it needed (societies of small isolated islands), to societies such as those of Tonga, the Societies, and Hawaii, with hereditary craft specialists including canoe builders, navigators, stonemasons, bird-catchers, toolmakers, and tattooers. Polynesian social organization ranged from nearly egalitarian on the atolls and Chathams, to the highly stratified societies of Tonga, the Societies, and especially Hawaii. The society of the latter archipelago was based on about ten hereditary, nearly endogamous castes, maintained in the highest classes by brother-sister marriage reminiscent of the Inca Empire.

Polynesian political organization ranged from local units of a few hundred people on small isolated islands, to self-contained

communities of one or two thousand people, each occupying a valley of the Marquesan Islands, to Tonga and Hawaii, whose political organizations approached the state level. These incipient states imposed taxation in the form of labor, carried out large public works projects, and maintained ownership of land in the hands of the chiefs. As for Polynesian culture, people of the Chathams manufactured only small, individually owned objects, but monumental architecture was produced on numerous islands (including Easter, Hawaii, Mangareva, the Marquesas, Societies, and Tonga), Hawaii had luxury goods produced for the chiefs by craft specialists, and Easter may even have developed writing.

To a considerable degree, these enormous differences among Polynesian societies can be related to differences in the environments that they inhabited. Roles of at least six relevant variables can be recognized: suitability for agriculture, isolation, area, island type, productivity, and geographic effects on the size of the largest political unit.

First, although most Polynesian islands were suitable for growing the Asian domesticated plants that the Polynesians brought with them and/or the native Pacific plants that they domesticated, two islands at high, nearly sub-Antarctic latitudes did not permit Polynesian agriculture: the Chathams and most of New Zealand's South Island. On these islands, the founding farmers inevitably became hunter-gatherers.

A second variable obviously critical to the size of the largest political unit that could be maintained is island isolation. Some Polynesian islands are so remote (Easter, the Chathams) that there is no evidence of any further Polynesians arriving after the first settlement, and there was correspondingly no known place to which the descendants of those first settlers could emigrate if their home island became overcrowded. The size of the largest political unit could obviously be no greater than Easter or the Chathams themselves. Other islands lie in archipelagoes where many islands are visible from each other, although the whole archipelago itself

is isolated (e.g., Hawaii). The Tongan archipelago consists not only of islands close enough for regular voyaging, but close enough to other archipelagoes (Fiji and Samoa) for regular trade. Thus, the whole Tongan archipelago eventually became cemented into a single political unit with trade relations and extensions of power to Fiji and Samoa.

Third, island size ranges from tiny atolls of a few acres, through giant Hawaii (6,400 square miles), to the miniature continent of New Zealand (100,000 square miles).

Fourth, island type varies from low flat atolls with thin soil and lacking permanent fresh water, to high volcanic islands with rich soil and permanent streams (e.g., the Societies and Marquesas). The larger islands variously have (most islands) or lack (Easter and the Marquesas) reefs and shallow water productive of fish and shellfish.

Correlated with these differences in island type and latitude were differences in human population density, dependent on plant growing conditions and access to seafood. Human densities ranged from about 1 person per 20 square miles on New Zealand's cold South Island, to 250 people per square mile on Hawaii, Tonga, the Societies, and Samoa, to 1,000 people per square mile on Anuta.

Finally, the size of the largest political unit reflected not only an island's total area or population, but also whether the island was fragmented by topography and accessible to other islands. For example, not only was the Marquesas Archipelago not unified politically, but neither were its individual islands, because populations on each island were confined to narrow, deep, steep-walled valleys separated by high ridges and communicated with populations of other valleys mainly by sea. In contrast, Easter Island is gently rolling, with no such barriers to human movements.

These differences in island geographic properties lead straightforwardly to the above-mentioned differences in population density and in number of people encompassed within a single political unit. Size of political unit is in turn correlated with economic diver-

sification, social stratification, political organization, and range of cultural products. These relations have been explored at length by archaeologist Patrick Kirch in his books *The Evolution of the Polynesian Chiefdoms* and *Feathered Gods and Fishhooks.*

Thus, Polynesia illustrates clearly how differences in geography can cause a single people to diversify quickly and greatly in their food supply, economy, social and political organization, and cultural products. Let us now consider whether differences in geography, operating for much longer times and on a much grander spatial scale, have similarly caused the observed diversity of peoples among the major continents themselves.

ATAHUALLPA AND PIZARRO: THE COLLISION OF THE OLD AND NEW WORLDS

The largest population shifts of modern times have been the colonization of the New World by Europeans and the reduction or disappearance of most groups of Amerindians (Native Americans). Discounting the few visits of small numbers of Norse to sites on the east coast of Canada, leaving no discernible impact or legacy, the collision of the Old and New Worlds began abruptly in 1492, after 10,000 years without demonstrated contact between the emerging complex societies of the two hemispheres. (This is not to deny continued contact across Bering Straits.) One of the most dramatic single moments in that collision was the first encounter of the Inca emperor Atahuallpa with the Spanish conquistador Francisco Pizarro at the Peruvian highland town of Cajamarca on November 16, 1532. Since that first meeting immediately resulted in the capture of Atahuallpa, and thereby led to the Spanish conquest of the Inca Empire, it provides a good starting point for analysis. We shall see that the reasons why Pizarro captured and killed Atahuallpa, rather than Atahuallpa doing the same to Pizarro's sovereign, are diagnostic for the collision of the two hemispheres, and for many other major collisions in recent world history.

The events that day at Cajamarca are well known, because they were recorded in writing by several of the Spanish participants. To get a flavor of those events, let us begin with excerpts from those eyewitness accounts:[1]

> The Indians' camp looked like a very beautiful city. So many tents were visible that we were truly filled with great apprehension. We never thought that Indians could maintain such a proud estate, nor have so many tents in such good order. Nothing like this had been seen in the Indies up to then. It filled all us Spaniards with fear and confusion. But it was not appropriate to show any fear, far less to turn back. For had they sensed any weakness in us, the very Indians we were bringing with us would have killed us. So, with a show of good spirits, and after having thoroughly observed the town and tents, we descended into the valley and into the town of Cajamarca.
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> We took many views and opinions among ourselves about what should be done. All were full of fear, because we were so few and were so deep in the land where we could not be reinforced. All assembled in the Governor's [Francisco Pizarro's) quarters to debate what should be done the following day. Few slept, and we kept watch in the square, from which the camp fires of the Indian army could be seen. It was a fearful sight. Most of them were on a hillside and close to one another: it looked like a brilliantly star-studded sky. There was no distinction between great and small or between foot-soldiers and horsemen. Every one performed sentry rounds fully armed that night. So also did the good old Governor, who went about encouraging the men. On that day all were knights. I saw many Spaniards urinate without noticing it out of pure terror.
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> [Pizarro] signalled the artillery man to fire the cannons into their [the Indians'] midst. They [the Spaniards] all placed rattles on their horses to terrify the Indians. With the booming of the shots and the trumpets and the troop of horses

[1] The following translation of the original Spanish texts is based on that by John Hemming in his book *The Conquest of the Incas* (San Diego: Harcourt Brace Jovanovich, 1970).

with their rattles, the Indians were thrown into confusion and panicked. The Spaniards fell upon them and began to kill them. They [the Indians] were so filled with fear that they climbed on top of one another —to such an extent that they formed mounds and suffocated one another. The horsemen rode out on top of them, wounding and killing and pressing home the attack.

The Governor armed himself with a quilted cotton coat of armor, took his sword and dagger and entered the thick of the Indians with the Spaniards who were with him. With great bravery he reached Atahuallpa's litter. He fearlessly grabbed [Atahuallpa's] left arm and shouted, "Santiago!" but he could not pull him out of his litter, which was on high. All those [Indians] who were carrying Atahuallpa's litter appeared to be important men, and they all died, as did those who were travelling in the litters and hammocks. Many Indians had their hands cut off but continued to support their ruler's litter with their shoulders. But their efforts were of little avail for they were all killed. Although [the Spaniards] killed the Indians who were carrying [the litter], other replacements immediately went to support it. They continued in this way for a long while, overpowering and killing the Indians. Seven or eight Spaniards spurred up and grabbed the edge of the litter, heaved on it, and turned it onto its side. Atahuallpa was captured in this way, and the Governor took him to his lodging. Those who were carrying the litter and those who escorted [Atahuallpa] never abandoned him: all died around him.

They [the Indians] were so terrified at seeing the Governor in their midst, at the unexpected firing of the artillery and the eruption of the horses in a troop —which was something they had never seen —that, panic-stricken, they were more concerned to flee and save their lives than to make war. The foot-soldiers set about those who remained in the square with such speed that in a short time most of them were put to the sword. All the other fighting men whom the Inca had brought were a mile from Cajamarca and ready for battle, but not an Indian made a move. When the squadrons of men who remained in the plain outside the town saw the others fleeing and shouting, most of them broke and took to flight. It was an extraordinary

> sight, for the entire valley of 15 or 20 miles was completely filled with men. It was a level plain with fields of crops. Many Indians were killed. Night had already fallen and the horsemen were continuing to lance Indians in the fields, when they sounded a trumpet for us to reassemble outside the camp. On arrival we went to congratulate the Governor on the victory.
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> In the space of two hours — all that remained of daylight — all those troops were annihilated. That day, six or seven thousand Indians lay dead on the plain and many more had their arms cut off and other wounds. Atahuallpa himself admitted that we had killed seven thousand of his Indians in that battle. The man killed in one of the litters was his steward (the Lord of Chincha), of whom he was very fond. The others were also lords over many people and were his councillors. The cacique lord of Cajamarca died. Other commanders died, but there were so many of them that they go unrecorded. For all those who came in Atahuallpa's bodyguard were great lords. It was an extraordinary thing to see so great a ruler captured in so short a time, when he had come with such might.
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> Truly, it was not accomplished with our own forces, for there were so few of us. It was by the grace of God, which is great.

Let us now trace out the chain of causation in this extraordinary confrontation. We begin with the most proximate question: Why was it that Pizarro captured Atahuallpa at Cajamarca and killed his followers, instead of Atahuallpa capturing Pizarro and killing Pizarro's followers? After all, Pizarro had only 62 soldiers mounted on horses plus 106 foot-soldiers, while Atahuallpa commanded an army of about 40,000. We shall then consider the next most proximate question: how Atahuallpa came to be at Cajamarca at all; how Pizarro came to be there; and why Atahuallpa walked into what seems to us, with the gift of hindsight, to have been such an obvious trap.

For each of these questions, we shall ask whether the responsible factors identified in the confrontation between Atahuallpa and Pizarro also played a broader role in the collision of the Old

and New Worlds, and in other collisions. Finally, we shall explore the ultimate factors responsible for the proximate factors that we have identified.

Why did Pizarro capture Atahuallpa? Pizarro's military advantages lay in steel swords and guns (Pizarro had both muskets and artillery), to which the Incas could oppose only stone and wooden weapons. In other similar confrontations throughout the New World and on other continents, steel weapons and guns proved similarly decisive in conquests of people lacking those weapons. This advantage of weaponry is too obvious to require further elaboration.

One other advantage enjoyed by Pizarro does, however, warrant examination. The tremendous advantage that the Spaniards gained from their horses leaps out of the eyewitness accounts. The shock of a horse's charge, the speed of attack that it permitted, and the raised fighting platform that it provided left foot-soldiers nearly helpless in the open. Similarly, Cortes's conquest of the Aztec Empire was carried out by a tiny force of 500 soldiers and 16 horsemen, armed with steel swords, muskets, and crossbows.

The military advantage of horses was not only due to the terror that they inspired in soldiers fighting against them for the first time. By the time of the Great Inca Rebellion of 1536, the Incas had learned how best to defend themselves against cavalry, by ambushing and annihilating Spanish horsemen in narrow passes. But the Incas, like all other foot-soldiers, were never able to resist cavalry in the open. When Quizo Yupanqui, the best general of the Inca emperor who succeeded Atahuallpa, besieged the Spaniards in Lima in 1536 and tried to storm the city, two squadrons of Spanish cavalry charged a much larger Indian force on flat ground, killed Quizo and all his commanders in the first charge, and routed Quizo's army. A similar cavalry charge of 26 horsemen routed the best troops of the Inca emperor Manco, as he was besieging the Spaniards in Cuzco.

The transformation of warfare by horses began around 4000 B.C., when the domestication of horses in the Russian steppes north of

the Black Sea empowered the first speakers of Indo-European languages to launch the spread of those languages over almost all of Europe and much of Asia. Horses permitted people possessing them to cover far greater distances than was possible on foot, to attack by surprise, and to flee before a superior defending force could be gathered. Horses proceeded to revolutionize warfare in the Near East and Mediterranean, especially following the invention of the horse-drawn battle chariot around 1800 B.C. In 1786 B.C., horses enabled the Hyksos to conquer then-horseless Egypt, and later enabled the Huns and Mongols to invade and terrorize Europe. Horse-drawn chariots transformed warfare in China, and also in the kingdoms emerging in West Africa around A.D. 1000. While our first image of North American Indians is often of mounted warriors on the Great Plains, we forget that horses arrived there only in the seventeenth and eighteenth centuries and proceeded to transform not only Plains warfare but also the Plains economy, by making it feasible to follow migrating herds of buffalo. As all of these examples illustrate, the role of horses at Cajamarca exemplifies their military value that lasted for 6,000 years and became applied on all the inhabited continents. Not until the First World War was the military dominance of cavalry finally superseded.

How did Atahuallpa come to be at Cajamarca? While the Incas would probably have succumbed eventually to the Spanish invaders, as did the Aztecs, even if Atahuallpa had not been captured at Cajamarca, his capture there on the second day of his contact with Spaniards simplified matters enormously for Pizarro. Atahuallpa and his army came to be at Cajamarca because they had just won decisive battles in a civil war that left the Incas divided and vulnerable. Pizarro quickly appreciated those divisions and exploited them to his advantage. The reason for the civil war was that an epidemic of smallpox or measles, spreading among South American Indians after its arrival with Spanish settlers on the coast, had killed the Inca emperor Huayna Capac in

1525 and then immediately killed his heir Ninan Cuyuchi, precipitating the civil war between Atahuallpa and his half-brother Huascar. If it had not been for the epidemic, the Spaniards would have been facing a united empire.

Atahuallpa's presence at Cajamarca is thus symbolic for one of the most important factors in the course of world history: diseases transmitted by invading peoples to settled peoples lacking immunity. Smallpox, measles, influenza, typhus, bubonic plague, and other infectious diseases endemic in Europe decimated many peoples on other continents and was a decisive factor in European conquests. For example, a smallpox epidemic devastated the Aztecs after the failure of the first Spanish attack in 1520 and killed Cuitlahuac, the Aztec emperor who briefly succeeded Montezuma. Throughout the Americas, diseases introduced with Europeans spread from tribe to tribe far in advance of the advancing Europeans themselves, killing an estimated 90 or 95% of the pre-Columbian Indian population, For instance, the most populous and highly organized Indian society of North America, the Mississippian civilization, disappeared between 1492 and the late 1600s, when Europeans themselves made their first beginnings of settlement on the Mississippi. Soon after the British settlement of Sydney in 1788, the first of the epidemics that decimated Aboriginal Australians began. A well-documented example from Pacific islands is the epidemic that swept over Fiji in 1806, when a few European survivors from the wreck of the ship *Argo* struggled ashore. Similar epidemics characterize the histories of Tonga, Hawaii, and other Pacific islands.

I should not leave the impression, however, that the role of disease in history was confined to paving the way for European expansion. Diseases of tropical Africa, India, Southeast Asia, and New Guinea greatly retarded European conquest and furnished the most important obstacle to European colonization of those areas.

How did Pizarro come to be at Cajamarca? Pizarro came to Cajamarca through European maritime technology, which built

the ships that took him across the Atlantic from Spain to Panama, and then in the Pacific from Panama to Peru. In addition to the ships themselves, his presence also depended on the political organization that enabled Spain to finance, build, staff, and equip the ships. Another related factor was the role of writing, in making possible the quick spread of much more detailed and accurate information than could be transmitted by mouth. That information coming back from earlier voyages motivated later European explorers and settlers to embark and provided them with detailed sailing directions. Maritime technology coupled with political organization was similarly essential for European spread to other continents, and for expansions of some other peoples (e.g., of Arabs along the coast of East Africa around 2,000 years ago).

Why did Atahuallpa walk into the trap? Armed with hindsight, we find it astonishing that Atahuallpa marched into such an obvious trap at Cajamarca. The Spaniards who captured him were equally surprised at their success.

The immediate explanation is that Atahuallpa had very little information about the Spaniards and their power and intent. He derived that little information by word of mouth, following Pizarro's landing on the Peruvian coast in 1527 and again in 1531. It simply did not occur to Atahuallpa that the Spaniards would attack him without provocation and that they were formidable.

Equally surprising to us today is Atahuallpa's behavior following his capture. He offered his famous ransom in the belief that, once paid off, the Spaniards would release him and then depart. He failed to understand that Pizarro's force was the spearhead of an invasion of permanent conquest, rather than an isolated raid.

Atahuallpa was not alone in these fatal miscalculations. After Atahuallpa had been captured, Francisco Pizarro's brother Hernando Pizarro persuaded Atahuallpa's leading general Chalcuchima, in command of a large army, to deliver himself into the Spaniards' power. The Aztec emperor Montezuma made an even grosser miscalculation when he took Cortes for a returning god

and admitted Cortes and his little army into the Aztec capital of Tenochtitlan.

On a mundane level, the miscalculations by Atahuallpa, Chalcuchima, Montezuma, and countless other native leaders deceived by Europeans were due to the fact that no living inhabitant of the New World had been to the Old World, so of course there could be no specific information available about the Spaniards. Even so, we find it hard to avoid the conclusion that Atahuallpa "should" have been more suspicious, had his society had experience of a broader range of human behavior. Pizarro too arrived at Cajamarca with no information about the Incas other than what he had learned by interrogating the Inca subjects he encountered in 1527 and 1531. However, while Pizarro himself happened to be illiterate, he belonged to a literate tradition. From written records, the Spaniards knew of many contemporary civilizations remote from Europe and knew several thousand years of European history. Pizarro explicitly modeled his ambush of Atahuallpa on the success of Cortes, who had advanced his conquest of the Aztec Empire by capturing the emperor Montezuma. In short, literacy made the Spaniards heirs to a huge range of knowledge of human behavior and history unavailable to the Incas and Aztecs. That knowledge encouraged Pizarro to set his trap, and Atahuallpa to walk into it.

Ultimate Factors Determining the Outcome of the Collision of Old and New Worlds

We have so far identified proximate factors in European colonization of the New World: military technology employing guns, swords, and horses; infectious diseases endemic in Eurasia; European maritime technology; the political organization of large and wealthy European states; and writing. Let us now enquire why these pioximate advantages came to characterize Europe rather than the New World. Theoretically, the Incas might have been the ones to develop Iron Age weapons and firearms, to be mounted

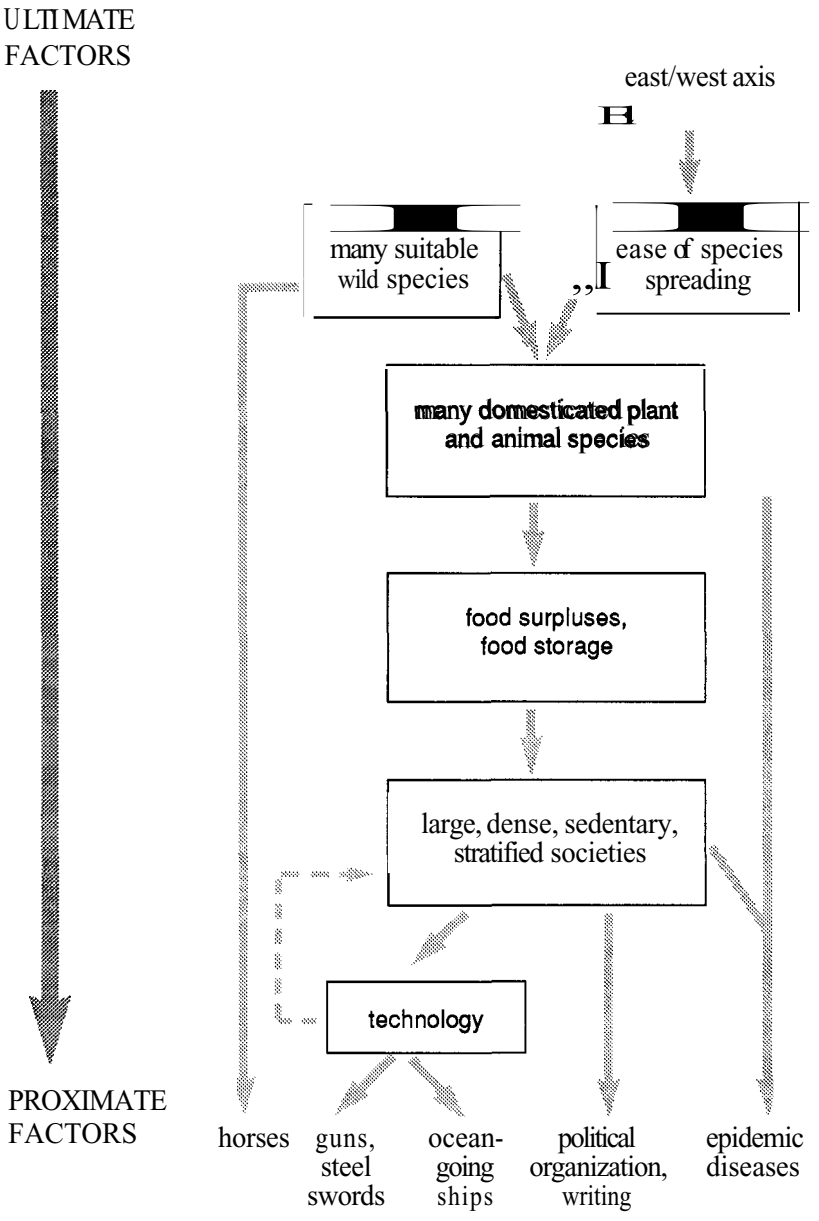
on animals more formidable than horses, to bear diseases to which Europeans lacked resistance, to have oceangoing ships and advanced political organization, and to be able to draw on the experience of thousands of years of written history. Why did these advantages go to the Old World, rather than the New World?

One convenient starting point for tracing the chain of causation (see figure) is to appreciate why Eurasia had evolved many more infectious diseases endemic in crowded populations than had the Americas. The infectious diseases of Eurasia owe their evolution to the domestic animals of Eurasia, for two reasons. First, many infectious diseases require large human populations in order to be able to maintain themselves. In a small population, an infectious disease may quickly infect the whole population, kill some people, and immunize the survivors, leaving the disease to die out because there are no more people left to infect. The size of the human population required to sustain an infectious disease depends on factors such as the duration of infection of each patient and the number of new victims infected per patient. Many of our familiar modern infectious diseases could have sustained themselves only in the large, dense human populations that appeared with the rise of agriculture and of human concentration into villages and cities. For example, measles requires a population of over 100,000 people in order to maintain itself.

Second, most human infectious diseases evolved from similar diseases of domestic animals with which humans came into close association. For instance, measles, smallpox, influenza, and falciparum malaria evolved from corresponding diseases of dogs, cattle, pigs, and birds (possibly chickens), respectively. It is striking that, whereas Europeans transmitted many diseases that caused devastating epidemics in Amerindians, the latter gave no diseases in return to Europeans —with the possible exception of syphilis (it remains uncertain whether syphilis arose in the Old or New World).

The paucity of crowd infectious diseases in the Americas partly reflects the fact that densely populated farming communities and

FACTORS UNDERLYING THE BROADEST PATTERN OF HISTORY



cities arose later in the New World than in the Old World. Even more importantly, it reflects the extreme paucity of domesticated animal species in the New World. New World domesticates consisted solely of the dog throughout the Americas, the llama and alpaca and guinea pig in the Andes, the turkey in North America and Mexico, and the Muscovy duck in lowland tropical South America. Contrast those few species with the wide range of domesticated animals in Eurasia: the horse, cow, sheep, goat, pig, and dog distributed widely throughout Eurasia; many local domesticates, such as reindeer and water buffalo; domesticated small mammals, notably rabbits and cats; and domesticated birds, including the chicken, mallard duck, and goose.

Why were far more animal species domesticated in Eurasia than in the Americas ? Since the Americas harbor several thousand wild bird species and a thousand or more wild mammal species, one might suppose that the Americas offered plenty of starting material for domestication. In fact, of wild mammal and bird species over the whole world only a tiny fraction has been successfully domesticated. Domestication requires that an animal be bred in captivity and genetically modified to make it more useful to humans. To be suitable for domestication, wild species must possess a suite of characteristics shared by only a few: willingness to breed in captivity, with mates selected by humans rather than by the individual animal itself; submissive behavior within groups or herds of its own species, a behavior that can be transferred to humans; and a diet that can be readily supplied by humans. Dozens of potentially valuable wild species, including Asian and Indian elephants and cheetahs, have been tamed but not domesticated. Thousands of years ago, humans domesticated almost all possible worthwhile wild mammal species, with the result that there have been no significant additions to our suite of domesticated large wild mammals in modern times, despite much effort put into attempts to domesticate species such as eland and American bison.

Eurasia ended up with the most domesticated species partly because, as the world's largest land mass, it offered the most wild species to begin with. That preexisting difference was magnified by the extinction, around 11,000 years ago at the end of the last Ice Age, of about 80% of the large mammal species of North and South America. Those extinctions included several species that might have been expected to furnish useful domesticates had they survived, such as North American horses and camels. As a result, Amerindians inherited far fewer species of large wild mammals than did Eurasians, leaving them only the llama and alpaca (possibly variants of the same wild species) as domesticates. We shall similarly see that sub-Saharan Africa, New Guinea, and Australia have yielded no large domesticated mammals at all, although Africa and New Guinea did yield domesticated plants.

Old World/New World differences in domesticated plants are qualitatively similar to these differences in domesticated mammals, though much less marked. The Americans did yield many valuable plants, of which maize, potatoes, tomatoes, and others have now spread worldwide. However, in contrast to the numerous productive domesticated grains of the Old World (wheat, barley, oats, millets, and others), the Americas yielded only one productive grain (corn), and the complexities of its reproductive system meant that the development of maize's wild ancestor (teosinte) to yield a productive crop required thousands more years of effort on the part of Amerindians than did the development of Old World grains.

Thus, Eurasia's advantage over the Americas in domesticated animal and plant species was initially due to the greater pool of candidate wild species in Eurasia, especially after the extinction of most large mammals of the Americas. A further advantage of Eurasia derives from the fact that its major axis is oriented east/west, whereas the major axis of the Americas is north/south. Eurasia's east/west axis means that its latitudinal bands and climate zones are 9,000 miles broad. Within these broad bands, wild

species adapted to that climate replace each other longitudinally as a result of local evolution. In contrast, the latitudinal bands of the Americas range from at most only 4,000 miles broad down to only a few hundred miles in parts of Central America and Patagonia.

As a result, species that were domesticated in particular parts of Eurasia were able to spread long distances within the climate band to which they were already adapted. For example, chickens and ducks domesticated in Southeast Asia quickly reached Europe; horses domesticated in European Russia reached China and Western Europe; and the sheep, goats, and cattle of the Mideast spread in all directions. The Romans already enjoyed Asian peaches and citrus fruit, Indian sesame and cucumbers, and Central Asian onions and hemp, in addition to the wheat and barley that they inherited from the Near East.

In the Americas, however, the llama, alpaca, guinea pig, and potato of the Andes were never able to spread through the tropical lowlands of northern South America and southern Central America to reach Mexico, with the result that Mesoamerican civilization remained entirely without pack animals. Correspondingly, the turkey, domesticated in Mexico and/or North America, was never able to reach the Andes. Maize did spread to South America and North America from its origins in Mexico, but it took thousands of years to transform the maize that evolved in Mexico's climate into a maize adapted to the shorter growing season and seasonally changing day lengths of North America, and thus to feed the rise of North America's Mississippian civilization beginning only around A.D. 1000. Various domesticated plant species, such as beans and cotton and tobacco, were grown in both North America and South America, suggesting at first sight that they did succeed in spreading through unfavorable climate zones. In fact, though, many of these seemingly shared species were actually domesticated independently in North and South America.

Domesticated plants and animals were important in many ways to the rise in human population densities and social and

political organization. Domestication allows people to become sedentary, whereas most hunter-gatherers move seasonally or more often in order to follow food sources. Domestication favors the storage of surplus food, thereby making some time available for purposes other than obtaining food. Domesticated plants and animals yield far more edible calories per acre than do wild habitats, in which most species are inedible to humans. As a result, population densities of farmers and herders are typically 10 to 100 times greater than those of hunter-gatherers. As already mentioned, those higher population densities favored the evolution of specialized infectious diseases of humans.

Domesticated mammals have been significant for reasons other than as a ready source of meat. Horses, cattle, and donkeys revolutionized land transport, permitting people to travel faster and further, carrying much heavier loads, than possible for people on foot. Several domesticated mammals yielded milk, as well as other useful products such as hides and wool. Livestock made it possible for an individual farmer to plough land faster, to plough soils that would otherwise have been uneconomical to plough, and thus to raise more food.

Those dense, sedentary populations made possible by plant and animal domestication were important in the development of human society and political organization for several reasons. First, a more numerous people has the advantage in wars of conquest and can extend its territory at the expense of a less numerous people. Before the European invasion of the Americas, some of the largest population shifts in the last 10,000 years of human history had involved expansions of farmers over the former territories of hunter-gatherers living at much lower population densities: the replacement of hunter-gatherers related to pygmies and modern Khoisan peoples (so-called Bushmen and Hottentots) over much of sub-equatorial Africa by Bantu farmers and herders; and the replacement of populations related to modern Papuans and Ab-

original Australians throughout Indonesia, the Philippines, and parts of Southeast Asia by the expansion of Austronesian farmers. Second, hunter-gatherer societies tend to be relatively egalitarian (without inherited chiefs) and to have small-scale political organization, at the level of the band or tribe, whereas moderate-sized agricultural societies are often organized in chiefdoms, and empires are confined to large agricultural societies.

Finally, in a large, dense society of settled farmers, a political upper class can free itself of the need to feed itself, and can thereby devote itself entirely to political activities, by obtaining surplus food from the primary producers through taxation. Taxation or barter of stored food surpluses also supports professional specialists who can devote themselves to the development of metallurgy, writing, and other technology. Food surpluses can also be used to support professional standing armies. This last consideration was the decisive factor in the eventual success of the British colonists of New Zealand at defeating New Zealand's well-armed indigenous Maori population. While the Maori were able to win stunning temporary victories, they could not maintain a professional army constantly in the field and were eventually worn down by the full-time soldiers of the colonists.

Thus, the Old World's greater number of domesticatable plants and especially animals, and the greater ease with which such species could spread through suitable climate zones in the Old World, contributed directly to most or all of the proximate advantages resulting in Old World colonization of the New World. The chain of causation is most straightforward in the case of the Old World's possession of horses; its suite of infectious diseases deadly to nonexposed peoples, its higher human population densities, and its earlier emergence of centralized states. The same factors contributed indirectly to the more rapid development of Old World technology, among whose achievements metal tools and weapons, firearms, and writing proved especially important.

AFRICAN COLLISIONS

As in Eurasia and the New World, agriculture did arise independently in certain parts of Africa — the Sahara and the zone immediately south of the Sahara. Best known of the native African domesticated plants is coffee, which was indigenous to Ethiopia and has now spread around the world. Other indigenous Ethiopian cultigens include the cereals known as teff and finger millet, the banana-like ensete, and the oil-yielding noog. The grains sorghum and bulrush millet were indigenous to (and domesticated in) the Sahara, while domesticates of tropical West Africa included African rice, African yams, groundnuts, and the oil palm.

However, sub-equatorial Africa has yielded no native plant cultigens. In addition, writing, herding, and possibly metallurgy did not arise independently in the Sahara and sub-Saharan Africa but entered from the outside. Most of sub-equatorial Africa was occupied by pygmy and Khoisan hunter-gatherers, until domestic livestock reached the latter around A.D. 0, just ahead of the invading farmers. Agriculture and metallurgy entered sub-equatorial Africa with the invaders themselves: the Bantu peoples, whose history constitutes one of the major population expansions and replacements of recent history. Originating from the area of tropical West Africa now within the borders of eastern Nigeria and southern Cameroon, the Bantu spread several thousand years ago to East Africa, whence around 2,000 years ago they suddenly expanded over almost the whole of southern Africa. That latter expansion carried them over a thousand miles in 200 years, from the East African lakes south to the shores of Natal. That Bantu expansion over southern Africa was powered by the advantages they derived from agriculture, herding, and metal.

Thus, African history has been molded by the local availability (or lack thereof) of domesticatable plant and animal species and by the long north-south axis of Africa that greatly slowed the spread of such species from north to south. Specifically, the Bantus'

suite of domesticatable plants halted their invasion of southern Africa before they could occupy the Cape of Good Hope, with heavy political consequences for the Republic of South Africa today.

With this brief introduction to African history, let us now consider Africa's domesticated animals in more detail. Almost all of those adopted south of the Sahara entered from the north, ultimately from Eurasia. The sole indigenous sub-Saharan domesticate is a bird, the guinea fowl. All of the mammalian domesticates —cattle, sheep, goats, horses, even dogs —entered sub-Saharan Africa from the north.

The lack of indigenous domesticated animals in sub-Saharan Africa may at first seem surprising, since we think of Africa as *the* continent of big wild mammals. In fact, none of Africa's famous big wild mammals proved domesticatable; even today, modern breeders have had no significant successes, except for some ongoing efforts with the eland, a large antelope. Consider how closely related some wild African mammals are to Eurasian species that did prove domesticatable. African zebras and rhinoceroses were never domesticated, though the Eurasian horse, a member of the same mammalian order (Perissodactyla, the odd-toed hoofed mammals), and a member of the same genus as the zebra, was domesticated with the momentous military results already discussed. All of Africa's famous antelope species, plus its buffalo and hippopotamus, could not be domesticated, although Eurasian cattle, sheep, and goats (members of the same mammalian order, Artiodactyla, or even-toed hoofed mammals) did prove suitable for domestication. Among the world's pigs, only the Eurasian pig has been domesticated —not Africa's indigenous bush pigs, giant forest pig, and warthog, nor the peccaries of the New World. African jackals were not domesticated, though the related Eurasian wolf (a member of the same genus) was.

Imagine what the course of African history might have been, had zebras, rhinoceroses, and hippopotamuses lent themselves to domestication! We have seen that cavalry mounted on Eurasian

horses proved invincible to peoples without horses. What would have happened if rhinoceroses or hippopotamuses had been domesticated south of the Sahara, and if subsaharan Africans mounted on those animals had then invaded North Africa and Europe? But that did not happen —because of Africa's suite of wild mammal species and their unsuitability for domestication.

Instead, as mentioned, the livestock adopted in Africa were Eurasian species that spread from north to south in Africa and thereby contributed to Africa's population buildup. That spread from north to south was much slower than the east/west spread of the same livestock species within Eurasia, because of difficulties in adapting to the different climate zones encountered along Africa's north/south axis, and because of problems of susceptibility to diseases of indigenous African mammals, such as trypanosomes transmitted by tsetse flies.

As one example of these difficulties of spread of domesticated mammal species along Africa's north/south axis, horses did not power the rise of West African kingdoms until the first millennium A.D., although horses had already reached Egypt around 1800 B.C. and transformed North African warfare soon thereafter. As a second example, cattle, sheep, and goats already reached Egypt, North Africa west of Egypt, and Sudan, and the Sahara at various times in the sixth and fifth millennium B.C. Those livestock reached the northern edge of the Serengeti in the third millennium B.C., where their spread halted. It took more than 2,000 years more for livestock to cross the Serengeti and reach southern Africa. Sheep reached South Africa around A.D. 0, cattle and goats and dogs a few centuries later —just ahead of the invading Bantu. As a final example, humped Zebu cattle originating from India have thrived better than humpless cattle in many parts of sub-Saharan Africa, but Zebu cattle did not reach East Africa until around A.D. 1500, even though they had reached Egypt by around 2,000 B.C. All of these examples illustrate the difficulties with which domesticated animals entering Africa from the north

adapted themselves to the climates and diseases that they encountered in their spread southward in Africa.

The rise of agriculture in southern Africa, where no indigenous domesticatable plant species occurred, was similarly delayed by difficulties in adapting along Africa's north/south axis. Agriculture is of considerable antiquity in Africa north of the equator: farming reached Egypt and the rest of North Africa, the Sahara, and Sudan already in the sixth and fifth millennia B.C., Ethiopia by 4000 B.C., and Nigeria around 3000 B.C. But it was not until around A.D. 0 that farming spread over most of sub-equatorial Africa. Four examples will illustrate the role of climate barriers along Africa's north/south long axis to that spread.

First, Mideastern and Mediterranean crops, such as the Egyptian staples of wheat and barley, require winter rains and seasonal variation in day length for their germination. Those crops were not able to spread south of the Sudan, beyond which they encountered summer rains and little or no seasonal variation in day length. Instead, the development of agriculture in the Sahara and sub-Sahara had to await the domestication of native plant species adapted to Central Africa's summer rains and relatively constant day length, such as sorghum and millet.

Second, and ironically, those same crops of Central Africa were unable to spread all the way south into the Mediterranean zone of South Africa, where once again winter rains and large seasonal variations in day length prevail! Instead, South Africa's Cape region required crops adapted to winter rains and seasonally varying day length, like the crops of the Mideast and Mediterranean. But those crops could not survive conditions in Central Africa and hence could not be transmitted overland through chains of farmers from the Mediterranean to the Cape. Instead, wheat and barley, oats and rye, and grapes reached the Cape only with European settlers in the seventeenth century. The Bantu advance southward halted in Natal, beyond which the zone of winter rainfall began. (That halt had notorious consequences for modern South African

politics, because the Bantu were not occupying the Cape when Europeans arrived. The indigenous population of the Cape consisted of Khoisan peoples, otherwise known as Hottentots and Bushmen, who were wiped out by European infectious diseases and murder.) The Cape was not the only part of Africa where the native African crops of sorghum and millet proved unsuitable: they also did not thrive in wet tropical West Africa, where the staples instead became yams and other crops domesticated from native West African plants.

Third, tropical Asia was the source of many tropical crops highly suitable for tropical Africa. Some of those Asian crops, such as bananas and plantains, lacked African counterparts. Others, such as Asian yams and taro, did have African counterparts, but the Asian species were more productive or else thrived better in Africa's wet climate zones than did native African species. Tropical America also yielded crops suitable for tropical Africa, notably maize and cassava. Those tropical Asian and American crops now provide the staple foods of most of sub-equatorial and tropical West Africa, rather than African native crops themselves. But the Asian crops did not reach Africa until around or after A.D. 0, presumably with Arab and Indonesian seagoing traders across the Indian Ocean. The tropical American crops did not reach Africa until after the arrival of Europeans in the New World. Had the Indian Ocean and Atlantic Ocean been bridged by land similar to the broad expanse of Eurasia, these productive and suitable crops would have reached Africa thousands of years earlier, just as Asian crops and chickens reached Europe early.

A final example involves the expansion of the eastern Bantu from East Africa southward. That expansion awaited the Bantus' acquiring sorghum and finger millet and cattle in East Africa; their kit of wet tropical West African domesticates was insufficient to enable them to spread throughout drier southern Africa.

Just as in Eurasia and the Americas, the spread of domesticated plants and animals through Africa and the resulting buildup of

human population densities and social and political organization were significant for the spread of technology. This fact is evident from the histories of writing, pottery, and metallurgy in sub-Saharan Africa. Although writing developed in Egypt by 3000 B.C. and had already reached Nubia by 850 B.C., it did not arise independently in the rest of Africa; it was brought in from the outside much later, by Arabs and Europeans. Second, pottery, like crops and domesticated animals, spread quickly through the northern half of Africa but then very slowly through sub-equatorial Africa. Pottery was recorded in the Sudan and Sahara around 6000 or 7000 B.C., from Ethiopia in the middle of the fifth millennium B.C., and from the fourth millennium B.C., in Ghana, but did not reach the Cape until around A.D. 0.

The history of metal in sub-Saharan Africa is more complex. It is clear that metallurgy was brought into most of sub-equatorial Africa from the outside, by the Bantu expansion around A.D. 0. However, it remains unclear whether metallurgy also reached sub-Saharan Africa solely from the outside or whether some developments were indigenous. In sub-equatorial Africa the first exploited metal was iron, which arrived very soon after iron was brought to Egypt and the rest of North Africa by the Phoenicians early in the first millennium B.C. Within a few centuries, iron technology is recorded in West Africa (Niger and Nigeria), very soon thereafter in the Lakes area of East Africa, and just after A.D. 0 throughout most of sub-equatorial Africa with the invading Bantu. Iron might similarly have reached tropical West Africa from the outside, spreading either from the Nile or across the Sahara from North Africa. However, bellows-driven furnaces to melt native copper were in use in Niger as early as 2000 B.C. It is therefore possible that that local technology evolved independently into copper smelting and then into iron smelting just before the arrival of iron from the north.

In short, domesticated plants and animals, which played a decisive role in the collision of the Americas and Eurasia, were doubly

decisive in African history. Sub-equatorial Africa lacked domesticatable plants and animals; Africa just south of the Sahara had numerous domesticatable plants, but no such animals except for the guinea fowl. The north/south long axis made the spread of useful plant and animal species throughout Africa slow and difficult.

Those facts had two major consequences. The first result was that the indigenous Khoisan people of most of sub-equatorial Africa never developed or adopted agriculture, and they acquired livestock from the north late, just before most of them were overwhelmed by the far more numerous, better-armed Iron Age Bantus. We do not know whether diseases carried by the Bantus played a role in their replacement of Khoisan peoples over most of southern Africa, but we do know that European diseases contributed heavily to Khoisan decimation in South Africa. The second result was that the Bantus, though their ancestors domesticated some plants locally in tropical West Africa, acquired other valuable domestic plants and animals only later from the north. The resulting advantages of Europeans in maritime technology, weapons, tools, and writing permitted Europeans to colonize Africa, rather than Africans colonizing Europe. A consequence of that European colonization is the geographically and socioeconomically crazy boundaries of modern African states, which inherited those boundaries from colonial regimes and which now find those boundaries undermining their economies and political stability.

AUSTRALIA

As of 1492, Australia remained the sole continent inhabited only by hunter-gatherers. There were no farmers or herders, no political organization beyond the level of the tribe or band, no writing, and no manufacture of metal tools. This outcome of Australian history has clearly been conditioned by three features of Australian geography.

First, to this day, no native Australian plant or animal species has proved suitable for domestication, except that some plant

species domesticated in New Guinea also occur (but were not domesticated) in a small area of tropical northeast Australia. Second, Australia had room for only a small population of hunter-gatherers. The continent's total area is about 3,000,000 square miles, compared to 9,400,000 for North America, and most of Australia's area is notoriously low in rainfall and productivity and can support only small human populations. As far as its ability to support hunter-gatherers is concerned, Australia is not a continent but only a medium-sized island, smaller even than New Guinea. The estimated total population of Aboriginal Australians at the time of European discovery was about 300,000.

Finally, Australia is not only small but effectively isolated, both by water barriers and by the contrasting habitats facing each other across those water barriers. Contact between Aboriginal Australia and outside humans, following Australia's sundering from New Guinea (formerly joined to the Australian continent) by rising sea level about 12,000 years ago, appears to have been confined to two areas in recent times. First, across Torres Straits from Australia's tropical Cape York Peninsula lies New Guinea, which developed or acquired the bow and arrow, agriculture, chickens, pigs, and pottery. None of those New Guinea features entered Australia. Although there was some trade along the island chain in Torres Straits, the influence of New Guineans on Australians was tenuous and did not diffuse beyond Cape York. Second, Indonesian fishermen seasonally visited northern and northwestern Australia, and some of their metal objects and other products have been found among coastal Australian peoples of those areas. However, that connection too was tenuous, may have begun only recently, and brought Indonesians to an arid and ecologically inhospitable part of Australia, unsuitable for developing agriculture even if the visiting Indonesians did carry domesticated plants and animals with them.

The resulting hunter-gatherer economy prevailing throughout Australia at the time of European discovery determined the out-

come of the European/Australian confrontation. European colonists sent out on oceangoing ships by centralized political states, carrying firearms, infectious diseases to which Australians lacked resistance, metal tools, and crops and livestock, decimated Aboriginal Australians unintentionally and intentionally.

Can we, however, attribute the differences between Australian and Eurorasian history solely to Australia's inability to support the independent development of native agriculture and herding? If this were true, one might expect human development in Australia to have kept pace with the pace in Eurasia, until plant and animal domestication beginning around 10,000 years ago finally made more complex social and political organization and technological development possible in Eurasia. However, in some respects the technology and development of Native Australia as of 1492 was less advanced than that of Late Pleistocene Europe, long before crops and livestock reached Europe. For example, Late Pleistocene Europe possessed the bow and arrow, a much more diverse kit of specialized stone tools, and apparently more extensive and diverse jewelry and art than did Australia. This suggests the possibility that factors already operating on hunter-gatherers slowed the pace of development in Australia compared to Eurasia. For further evidence of this speculation, let us now turn to the contrast within the Australian region, between mainland Australia and the nearby island of Tasmania.

TASMANIA

Tasmania is an island of about 27,000 square miles, lying 130 miles south of the Australian mainland, in the temperate zone at the latitude of Chicago or Vladivostok. When discovered by Europeans in 1642, Tasmania was occupied by 4,000 people physically rather similar to mainland Australians, but with the simplest technology of any recent peoples on earth. Tasmanian technology was considerably simpler than that of the Aboriginal Australians on the opposite mainland of Australia, with which Tasmania had

been connected at Late Pleistocene times of low sea level until the land bridge was severed around 12,000 years ago.

Features of mainland Australian culture absent in Aboriginal Tasmania include the following. Tasmanians were unable to light a fire *de novo;* if a family's fire went out, they had to rekindle it from the fire of another family. Tasmanian weapons were restricted to a hand-held spear and club; lacking were the spear-thrower, boomerang, and shields of mainland Australia. Tasmanian tools were made solely of stone and wood, without the bone tools of mainland Australia. Those stone tools were very simple and consisted just of scrapers without ground edges, in contrast to the much more diverse and specialized stone tools of the opposite Australian mainland. With only those scrapers, Tasmanians were unable to fell a tree or hollow out a canoe. Those Tasmanian scrapers were one-piece unhafted tools, unlike the compound or hafted axes and adzes of mainland Australia. Since the Tasmanians lacked sewing, they were unable to sew bark canoes or compound clothing, and their clothing consisted only of single-piece capes thrown over the shoulder. The Tasmanian lacked nets, traps, and ropes. Instead of canoes, which they could not hollow out or sew, their watercraft consisted solely of rafts capable of remaining afloat for only about ten miles, thereby preventing Tasmanians from exploiting the resources of islands lying further offshore. Despite living mostly on the seacoast, the Tasmanians did not catch fish.

One cannot reasonably argue that all of those cultural inventions would have been unhelpful and that the Tasmanians had a material culture perfectly adequate to their needs. For humans anywhere in the world, it is convenient to be able to light a fire oneself, and a bow or spear-thrower can discharge a projectile further and with greater force than can a hand-held spear. Nets and traps are useful to any hunter of small game. Despite Tasmania's cold wet winters, the Tasmanians lacked warm clothes, techniques of food storage, and substantial winter houses that

would have increased their comfort and protected them against respiratory diseases. Fish have been found a useful source of protein by practically all other peoples living on the seacoast. How did these extraordinary deficits in Tasmanian material culture arise?

We know that Tasmania was occupied by people long before the land bridge connecting Tasmania to southern Australia was severed 12,000 years ago. That is, although Tasmania is now an island, people walked to Tasmania tens of thousands of years ago. Once that land bridge was severed, however, there was absolutely no further contact between the peoples of Tasmania and mainland Australia for 12,000 years, because both peoples lacked watercraft capable of crossing the intervening water barrier of 130 miles and because the islands in those straits were uninhabited. The Tasmanians thus lived in their own isolated universe for 12,000 years, until Europeans began to settle their island around 1800 and exterminated them within a few decades. Tasmanian history is a story of human isolation unprecedented —except in science fiction.

From Tasmania's lack of many material objects present on the opposite Australian mainland, we can surely conclude that Tasmanians did not independently invent those objects if they were invented in Australia. (Perhaps some of those objects entered mainland Australia from New Guinea or Indonesia following the isolation of Australia and were not invented by either Tasmanians or Australians.) Astonishingly, the archaeological record reveals that Tasmanians also *abandoned* some cultural practices that they brought with them from Australia and that persisted on the Australian mainland. Those losses include bone tools and the practice of fishing, both of which disappeared from Tasmania around 1500 B.C. Bone tools were initially present in Tasmania as spatulas, awls, and needles, which might have been used to sew warmer clothes than those used by Tasmanians as of 1642. Fish had formerly constituted about 20% of the meat intake of Tasmanians and could have been smoked to provide a winter food supply.

Nevertheless, fishing was abandoned, even though the same fish species that Tasmanians used to catch still occur and are easily caught in Tasmanian coastal waters.

What sense can we make of these losses? Just as some anthropologists have tried to argue that Tasmania's very simple material culture in other respects was adequate, they have also tried to argue that bone tools and fishing were not useful to Tasmanians, or even that Tasmanians were better off not fishing. These rationalizations seem to me to defy common sense. Instead, the question should be phrased why Tasmania lost these practices *despite* their obvious utility.

An interpretation developed by Australian archaeologist Rhys Jones goes as follows. All human societies experience fads, in which they temporarily either adopt practices of little use or else abandon useful practices. For example, peoples on various Pacific islands have temporarily decided to taboo or dispense with pigs, even though pigs were their sole edible land mammal other than dogs and rats! There are several instances of people killing off all the pigs on their island, only eventually to realize that pigs were useful after all and to import a new breeding stock of pigs from other islands. Similarly, ancestral Polynesians made pottery, but derived Polynesian society abandoned the making of pottery, a loss or taboo for which no one has been able to suggest a reasonable economic motive.

Whenever such senseless taboos or losses arise in an area with many competing human societies, only some societies will adopt the taboo at a given time. Other societies will retain the useful practice and will either outcompete the societies that lost it or else will be there as a model or source for the societies with the taboos to repent their error and reacquire the practice. Had Tasmanians remained in contact with mainland Australians, they could have relearned the skill of fishing or making bone tools, or alternatively they might have been outcompeted and replaced by tribes retaining

these useful arts. But that could not happen in Tasmania, with only 4,000 people divided among nine tribes. Under those circumstances, the cultural losses were more likely to be irreversible.

Such cultural losses in isolation were not unique to Tasmania. The Chatham Islands, lying in sub-Antarctic waters several hundred miles east of New Zealand, were settled about a thousand years ago by New Zealand Maori who had to abandon farming, became hunter-gatherers, and gave rise to an isolated society of 2,000 people. Over the eight centuries between founding and European discovery, the Chatham Islanders also underwent a simplification of material culture and restricted their useful variety of fishhooks, bird spears, polished adzes, and ornaments. A possible second example is that the rising seas that isolated Tasmania from Australia simultaneously isolated two other islands or island groups lying between Tasmania and Australia, Flinders and King. Each of these islands was large enough to hold only a few hundred hunter-gatherers. Stone tools discovered by archaeologists show that both Flinders and King formerly supported human populations, but it is unknown how long these populations survived the rising sea levels that isolated them. Perhaps a few hundred hunter-gatherers are too few to maintain human society indefinitely in total isolation, with the result that these populations of Flinders and King died out. Finally, there are about a dozen cases of former Polynesian populations disappearing on very small, isolated Polynesian islands, of which Pitcairn is best known because of its rediscovery by the *Bounty* mutineers many centuries after the disappearance of Pitcairn's former population. Again, the populations of these so-called mystery islands of Polynesia may just have been too small to survive indefinitely in isolation.

Thus, the most likely message of the differences between Tasmania and mainland Australia is that, all other things being equal, the rate of human development is faster, and the rate of loss slower, in areas occupied by many competing societies with many individuals. If it is valid to draw this conclusion for the compari-

son of 4,000 Tasmanians with 300,000 mainland Australians, perhaps the same principle also contributed to the differences between Australia's hunter-gatherers and those of much larger Eurasia, or between the farmers of sub-Saharan Africa, the much larger Americas, and the still larger Eurasia.

CONCLUSION

As for the overall meaning of this whirlwind tour through human history, it is that our history has been molded by our environment. The broadest pattern of human history —namely, the differences between human societies on different continents — seems to me to be explicable in terms of differences in continental environments. In particular, the availability of wild plant and animal species suitable for domestication and the ease with which those species could spread without encountering unsuitable climates have contributed decisively to the varying rates of rise of agriculture and herding. Agriculture and herding in turn have contributed decisively to human population numbers, population densities, and food surpluses, and hence to development of human society and politics. In addition, the story of Tasmania and other isolated societies gives us a hint that the number of competing societies itself may have been a factor in human development.

As a biologist usually at home in laboratory experimental science, I am acutely aware that these interpretations can be dismissed as unprovable speculation. The same objection can be raised against any historical interpretation. That is the reason why we are uncomfortable about considering history a science —it is classified as a social science, which is not considered quite scientific.

Nevertheless, remember that the word "science" is not derived from the Latin word for "experiment" but from the Latin word for "knowledge." In science, we seek knowledge and understanding by whatever means are available. There are many fields which no one hesitates to consider sciences, even though we cannot do experiments —fields such as astronomy, paleontology, and much

of geology and evolutionary biology. We cannot manipulate stars, start and stop ice ages, or play with evolving dinosaurs, but we can still gain considerable insight into these basically historical fields by other means. We surely ought, then, to be able to understand human history, since introspection gives us more insight into the ways of past humans than of dinosaurs. For that reason I am optimistic that we really can eventually arrive at convincing explanations for the broadest pattern of human history.