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12

Ecology and Theology

Religion and Science

ECOLOGY IS A PROBLEM that we normally identify with modern industrial society. We are not used to associating ecology with theology, or with medieval history. But this chapter makes that association to suggest that our ecological problems lie very deep. Although we may have "discovered" an environmental crisis only recently, its causes go back at least as far as the Western industrial revolution of the last few centuries. The point of this chapter is that the industrial revolution itself, and the transformation of the human relationship to nature that it entailed, had even earlier causes in Western thought and action. Why, after all, was it Western Europe, of all places, that initiated the industrial revolution? This chapter will explore some of the cultural traditions that might have prepared the way.

Specifically, we will examine two Western cultural traditions that have been linked by some scholars to our ecological and environmental problems. They are the Western religious, or Judeo-Christian, tradition, and the development of science. Christianity and modern science might almost be called the hallmarks of Western culture. Although much of Western history is contained in the struggle

examine the continuity between Christianity and science in order to explore the roots of Western predominance over nature and the world.

We are therefore raising a number of issues that should be kept in mind. We are asking about the relationship between religion and science, and specifically between Christianity and the development of modern science. We are asking about the validity of tracing such a modern issue as ecology back to the Middle Ages when ecological issues were minimal or nonexistent. We are asking about the different "ideas of nature" that are found in different religious traditions. And we are asking to what extent such ideas matter in people's daily confrontations with the natural environment.

We will proceed by first examining the argument that the Judeo-Christian religious tradition shaped Western ideas of nature in a way that made the natural world more exploitable. Then we will ask if religious ideas really matter all that much by examining some of the inconsistencies between religion and practice in other religious traditions. Then we will survey the link between Western religion and science and examine some of the assumptions about nature that were implicit in the Western scientific revolution.

THE RESPONSIBILITY OF THE JUDEO-CHRISTIAN TRADITION

Those scholars who have argued that the roots of our ecological problems lie with the Judeo-Christian attitude toward nature emphasize the uniqueness of Judeo-Christian monotheism compared with more "primitive" polytheistic, animistic, and "nature" religions.

Arnold Toynbee put the case this way:

> The thesis . . . is that some of the major maladies of the present-day world—for instance the recklessly extravagant consumption of nature's irreplaceable treasures, and the pollution of those of them that man has not already devoured—can be traced back in the last analysis to a religious cause, and that this cause is the rise of monotheism.[1]

Why monotheism? What does the ancient Hebrew insistence that there is only one God have to do with our modern ecological problems? Toynbee's answer is to remind us that the monotheism of the Hebrew Bible was an injunction against older forms of nature worship, and that once monotheism was fully accepted in Judeo-Christian culture, nature could be exploited instead of worshiped. "For premonotheistic man," Toynbee points out,

> nature was not just a treasure trove of "natural resources." Nature was, for him, a goddess, "Mother Earth," and the vegetation that sprang from the Earth, the animals that roamed, like man himself, over the Earth's surface, and the minerals hiding in the Earth's bowels, all partook of nature's divinity.[2]

The Bible not only deprived nature of its ancient sacred awe in order to acclaim a higher creator God. It also specifically counseled mankind to subdue the natural world. Here Toynbee and others point to the injunction in Genesis 1:28:

> And God blessed them: and God said unto them, Be fruitful, and multiply, and replenish the earth, and subdue it; and have dominion over the fish of the sea, and over the birds of the heavens, and over every living thing that moveth upon the earth.

It is difficult to know what to make of a logical connection between monotheism and the desacralization of nature, or of any specific statements in the Bible. One wants to know if Jews and Christians actually behaved more arrogantly toward nature because of these ideas. In this regard, the work of Lynn White, Jr., a historian of medieval Christianity, technology, and science, makes a more formidable case for the responsibility of the Judeo-Christian tradition.

White's essay "The Historical Roots of Our Ecologic Crisis" has become a classic, reprinted many times since its first publication in *Science* in 1967. It was prompted, he tells us elsewhere, by watching Buddhists in Ceylon build a road.

> Noting cones of earth left undisturbed upon the intended roadbed, he discovered that these were the nests of snakes. The Buddhists would not destroy the cones until the snakes departed of their own accord from the scene of activity. Among other things, White could not help reflecting that had the road builders been Christian, the snakes would have suffered a different fate.[3]

White's essay begins with two points worth repeating:

> One thing is so certain that it seems stupid to verbalize it: both modern technology and modern science are distinctively *Occidental.* Our technology has absorbed elements from all over the world, notably from China; yet everywhere today, whether in Japan or in Nigeria, successful technology is Western. . . .
>
> A second pair of facts is less well recognized because they result from quite recent historical scholarship. The leadership of the West, both in technology and in science, is far older than the so-called Scientific Revolution of the 17th century or the so-called Industrial Revolution of the 18th century.[4]

Lynn White himself has contributed much to the view that Western technological inventiveness and dominance can be traced back to the Middle Ages. His book *Medieval Technology and Social Change* shows (among other things) the revolutionary effects of such an apparently simple invention as the stirrup for medieval society. Others (see Lewis Mumford, for instance) have found the origins of modern ideas and methods of work in the medieval monastery. In this essay, however, White draws our attention to the transformation of agriculture in Christian Europe about the time of Charlemagne (whose coronation was in A.D.

800). In this period, White relates, the peasants of northern Europe began to use a plow that turned over the land more violently than anything known before. Previous plows only scratched the surface of the soil. These new plows not only cut into the soil with a vertical knife, but they also cut underneath with a horizontal knife and turned the land completely over with a moldboard (a curved attachment that twisted the freshly cut sod). This system of plowing (which is still the method of modern tractors) caused so much friction with the soil that it required eight oxen instead of the usual two.

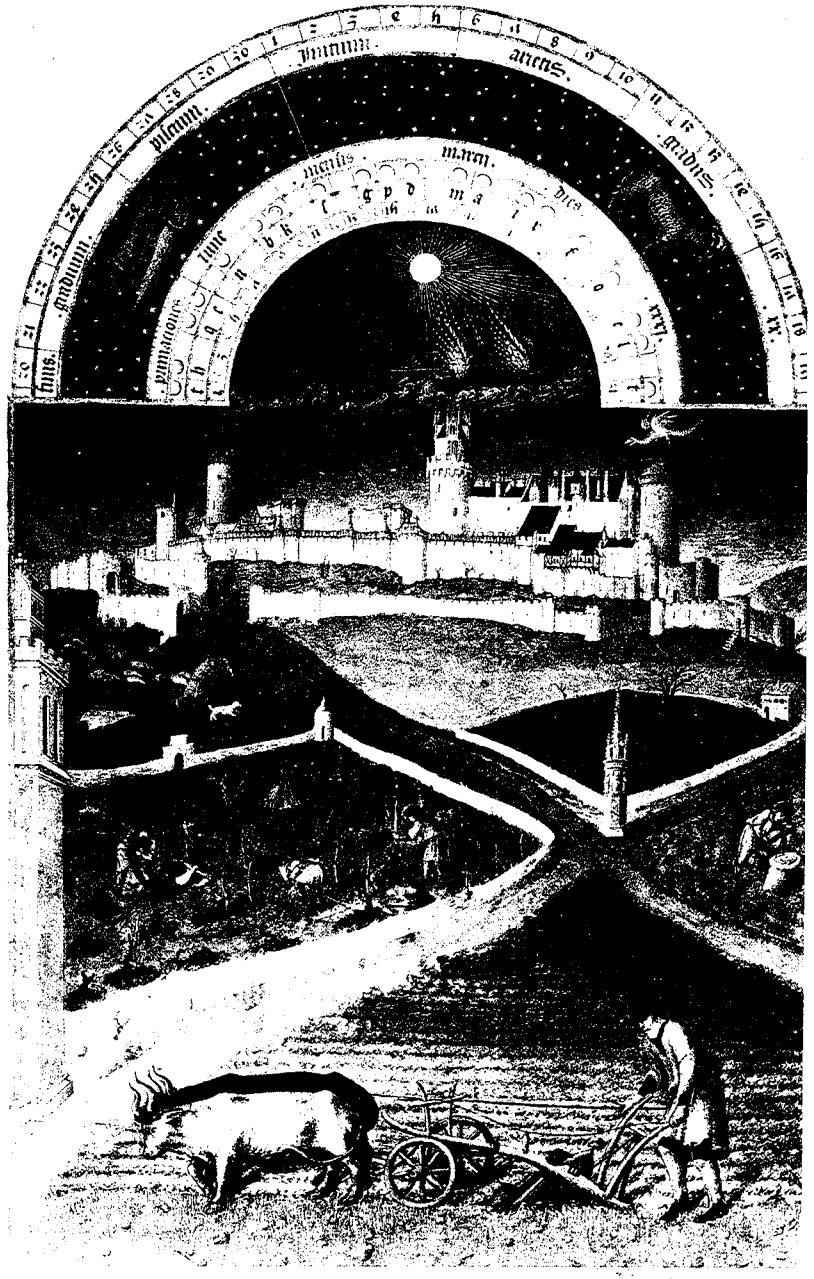
The new plow brought with it a much more aggressive attitude toward nature because of the kind of society that it required.

> In the days of the scratch plow, fields were distributed generally in units capable of supporting a single family. Subsistence farming was the presupposition. But no peasant owned eight oxen: to use the new and more efficient plow, peasants pooled their oxen to form large plow teams, originally receiving (it would appear) plowed strips in proportion to their contribution. Thus, distribution of land was based no longer on the needs of a family but, rather, on the capacity of a power machine to till the earth. Man's relation to the soil was profoundly changed. Formerly, man had been part of nature; now he was the exploiter of nature. Nowhere else in the world did farmers develop any analogous agricultural implement. Is it coincidence that modern technology, with its ruthlessness toward nature, has so largely been produced by descendants of these peasants of northern Europe?
>
> This same exploitive attitude appears slightly before 830 in Western illustrated calendars. In older calendars the months were shown as passive personifications. The new Frankish calendars, which set the style for the Middle Ages are very different: they show men coercing the world around them—plowing, harvesting, chopping trees, butchering pigs. Man and nature are two things, and man is master.[5]

The separation of man and nature that White notices in medieval calendars was certainly not completed by the ninth century, even in the most Christian sections of Europe. The peasant idea of a living nature persisted, we shall see shortly, as an obstacle to the scientific revolution well after 1500. Indeed, even today Greek peasants sing of their mother fields and daughter olive trees. But the question that White poses is whether Judeo-Christian monotheism has been playing a role in creating that separation. To answer this, let us look at some of the alternate visions of nature in polytheism and Eastern religions.

ALTERNATE VISIONS: POLYTHEISM AND ANIMISM

To say that the Judeo-Christian victory over polytheism was an unmitigated environmental disaster is to say too much. Polytheistic religions could also encour-



In this French calendar scene of March from the early fifteenth century, we see the coercion of nature that Lynn White, Jr., refers to. Peasants are clearing the brush, planting, and plowing (with an early moldboard plow that requires only two oxen). Above, the signs of the zodiac suggest much older, naturalistic images of the months. (From Les trés riches heures du duc de Berry, *Giraudon, Musée de Condé)*

age environmental exploitation. Roman polytheists mined mountains and exploited natural resources more than early Christians did. Polytheism is literally the belief in many gods. We must ask who those gods were, and what they protected. Romans worshiped civic and imperial gods who were easily disposed to exploitation, as well as nature gods who were not. Most polytheists, however, were animists: they believed that the natural world was full of *anima* (spirits or souls). That was a belief that could offer considerable protection to the natural environment.

Most tribal societies were animistic and polytheistic. But these are the categories of the missionaries and anthropologists, and so they are sometimes sources of confusion. Most African and Native American peoples, for instance, were polytheists. But they were also monotheists. Missionaries, not Africans, had to classify people into monotheists and polytheists. Two scholars of African culture put it this way:

> All African religions are monotheistic in the sense that there is a single High God, who is said to be the creator of the world and of mankind, and a central source of order and of whatever sense is to be found. Many African religions are also polytheistic in that either pantheons of gods or large numbers of spirits or ancestors or some other kind of divinities may stand between man and the ultimate God.[6]

Traditional African religions are called "animist" to designate their awareness of the living force in nature. Animism is not the "nature worship" that missionaries imagined. It is rather a sense of commonality with, or participation in, nature, and a belief that cooperation with nature is essential. This belief is suggested by a traditional prayer by the official "keeper of the community woods and forests" among the Didinga people of the Sudan:

> O Earth, wherever it be my people dig, be kindly to them. Be fertile when they give the little seeds to your keeping. Let your generous warmth nourish them and your abundant moisture germinate them. Let them swell and sprout, drawing life from you, and burgeon under your fostering care. . . .
>
> . . .
>
> O rivers and streams, where the woodman has laid bare the earth, where he has hewn away the little bushes and torn out encumbering grass, there let your waters overflow. Bring down the leafy mould from the forest and the fertilizing silt from the mountains. When the rains swell your banks, spread out your waters and lay your rich treasures on our gardens.
>
> . . .
>
> Conspire together, O earth and rivers: conspire together, O earth and rivers and forests. Be gentle and give us plenty from your teeming plenty. For it is I, Lomingamoi of the clan of Idots, who speaks, Keeper of the clan lands, Warden of the Forest, Master of the clan.[7]

NATIVE AMERICAN ENVIRONMENTAL RELIGIONS

The polytheism of Native Americans is perhaps more extensive than that of African societies. At least the monotheistic belief in a creator God is not universal among them, as it is among Africans.[8] More common is the belief in an earth goddess or mother goddess. She is found in North and South America, in cities as well as farming villages, and even among hunting-gathering peoples. As an example of the last, there is the testimony of Smohalla, charismatic chief of the Shahaptin peoples of the state of Washington in the 1880s. When pressured by the military to give up hunting and learn farming, he replied:

> You ask me to plow the ground. Shall I take a knife and tear my mother's bosom? Then when I die she will not take me to her bosom to rest. You ask me to dig for stone. Shall I dig under her skin for her bones? Then when I die I cannot enter her body to be born again. You ask me to cut grass and make hay and sell it, and be rich like white men. But how dare I cut off my mother's hair?[9]

Native American religion has been called an "environmental religion"[10] because of the centrality of concerns like these. The relationship of humans and nature was almost a preoccupation. Nature was the source of life. It gave birth to humans and fed them. But hunters had to kill the animals, and farmers had to cut the ground. It was a relationship that required constant attention. Thus, hunters apologized to animals for having killed them.

> Ethics included rules against boasting about hunting prowess. . . . They included the idea that humans could not kill animals at improper times, such as bears when they hibernated, or any animal when a member of the immediate family was expecting the gift of life.[11]

Such rules could not always be observed, and people had to eat. But even the taking of animal life was part of a religious context of mutual obligation between humans and animals. When a Wintu hunter was unable to kill a deer, it was because "deer don't want to die for me." Hunters would charm their prey to die for them. The culture hero of the Ojibwa was always trying to outwit the animals so that he could control them. The hunters were not always successful. But when they failed, there had to be a reason, and the reason might just as readily lie with the animals as with themselves. When the compact between humans and animals broke down, "humans fell into dis-ease from nature."[12] According to a common myth, when humans began to kill too many animals, the animals retaliated by creating diseases; but the plants took pity on the humans and offered a cure. Epidemic disease might, in fact, have provided a reason or excuse for the Eastern Algonkin to participate in the international fur trade as retaliation against the animals that were thought responsible for the epidemic.[13] Thus, the relationship often produced

frustration, guilt, and anger toward the animals. But even then, it was a relationship.

ALTERNATE VISIONS: EASTERN RELIGIONS

The term "animism" was first used by the anthropologist Edward Tylor to refer to the religious beliefs of some of the Indians of Asia (and then later applied to the "Indians" of the New World). Respect for nature was certainly an important concern of Hinduism, and especially of Buddhism and Jainism.

The Jains, followers of Mahavira, who was a contemporary of the Buddha, were the most unrelenting on this point. The following is from the Jain *Book of Sermons:*

> *Earth and water, fire and wind,*
> *Grass, trees, and plants, and all creatures that move,*
> *Born of the egg, born of the womb,*
> *Born of dung, born of water—*
> *These are the classes of living beings.*
> *Know that they all seek happiness.*
> *In hurting them men hurt themselves,*
> *And will be born again among them.*[14]

Indian Hinduism in the period after the classical age became more devotional. *Brahmans* had learned that the mass of people preferred devotion *(bhakti)* to a personal God over ritual and sacrifice. They translated the Upanishads and composed popular songs in local languages, and they joined in the singing of their praises to Shiva and Vishnu. Devotion to a personal God, even a Creator God, did not exclude nature, however, anymore than it did in the Upanishads. A song by Shankaradeva (1449–1568) shows how the creator God could still be identified with nature:

> Thou art the Author of the World. Thou art the Oversoul and the sole Lord of the world, and nothing else exists besides Thee. Thou art the cause and effect, the universe of the static and the moving, even as an ear ornament is inseparable from the gold of which it is made. Thou art the animals and the birds, the gods and the demons, the trees and the shrubs. Only the ignorant taketh Thee as different [from the universe].[15]

Both Chinese Daoism and Buddhism expressed reverential attitudes toward nature. The "Dao" was the way of nature. "Let there be no action contrary to the Dao," the *Dao De Jing* [*Tao Te Ching*] advised, "and nothing will go unregulated." A common Daoist belief held that "even insects and crawling things, herbs and trees, may not be injured." Schools of Buddhism in traditional China varied on matters of doctrine, but they shared a reverence for nature only slightly less central.

This is a typical example of the popular Chinese art of landscape painting. As is usually the case in this art form, human beings are barely noticeable. The artist is much more interested in the towering beauty of the natural world. Even when the Chinese artist painted a city (like Hangzhou in the previous chapter) nature is predominant. Compare our views of Florence. (Freer Gallery of Art)

IDEALS VERSUS BEHAVIOR?

One should not assume that all Chinese (even all Daoists or Buddhists) approached nature with such concern, however. The student of traditional China reads of official inspectors of the mountains and forests, prohibitions against cutting trees except at certain times, and other enforced conservation practices. But one also hears why such rules were necessary. Reports of deforestation, soil erosion, and flooding are common. After the tenth century, Chinese manufacturing had so depleted the timber reserves that it became increasingly necessary to substitute coal for wood.

From the Tang dynasty to the late Southern Song, China experienced a technological and economic boom that almost became an industrial revolution, like that which transformed Europe five hundred years later. Iron production reached per capita amounts that were not equaled until the British industrial revolution in the eighteenth century. Paper, paper money, printing, and publishing fueled an intellectual and financial revolution not equaled by the European Renaissance. New agricultural techniques—especially in wet rice cultivation, new seeds and fertilizers, iron plows with moldboards, doubling cropping that enabled two harvests a year—aided by widespread distribution of published work on the new techniques gave China "probably the most sophisticated agriculture in the world, India being

the only conceivable rival"[16] by the thirteenth century. With the invention of gunpowder, iron bombs, and the gun by the Chinese and the invading nomadic Jin [Chin] in the 1220s, warfare entered the modern age. With the mariner's compass, star charts, and navigator's manuals, Chinese ships sailed from Japan to Arabia and East Africa between 1405 and 1433. Chinese ships were the travel choice of foreigners during the Song and early Ming dynasties.

Much of this economic prosperity was reversed by the Mongol invasions and the Mongol Yüan (1279–1368) dynasty and the following Chinese Ming (1368–1644). But the dynamism of Chinese society—its expansion throughout the southeast and the Yangtze Valley, its systematic technological innovation, and its economic, industrial, and intellectual productivity—raises a number of questions. Why was China so expansive? How did such dynamism occur in a Buddhist or Daoist culture?

Perhaps the expansion of Song China occurred despite Buddhist and Daoist ideas. Perhaps it should be seen as the culmination of other traditions, notably Confucianism, which regained favor under the Song. The revival of Confucianism, often called neo-Confucianism in the West, was an effective counter to the spiritualism and social indifference of many Buddhist and Daoist thinkers. Confucian values motivated reformers like Fan Zhongyan [Fan Chung-yen] (989–1052), who said a true Confucian was "one who is first in worrying about the world's problems and last in enjoying his own pleasures," and Wang Anshi (1021–2086), who played a key role in developing a national money economy. The Confucian revival called for a renewed attention to matters of state and invested heavily in education. One of the elite schools, the White Deer Grotto Academy, was run for a time by Zhu Xi [Chu Hsi] (1130–1200), the Song's preeminent Confucian philosopher. The expansion of China during the Song was in keeping with Confucian human and material values rather than Buddhist or Daoist spiritualism.

Chinese ecological ideals must also be reconciled with the building of such gigantic cities as Changan and Hangzhou. Villages and rural roads were usually laid out according to the principles of *fengshui:* a preference for following the lay of the land, the natural hills and curves, and a distaste for straight lines, geometrical grids, or structures that seemed to dominate nature. But *fengshui* was virtually ignored in the construction of Changan. The astronomers who laid out the thirty-one-square-mile site sought conformance to the heavens rather than the earth. They carefully measured the shadow of the noon sun and the position of the north star in order to align the city of the Son of Heaven, its walls and gates, with the four directions. In the process, villages were leveled and (according to legend) all of the trees, except the old locust that shaded the chief architect, were uprooted.[17]

If Changan, with its broad straight avenues, conformed to an astronomer's idea of nature, Hangzhou was constructed according to the ideals of a romantic artist. Nature was not followed. It was reconstructed. The many parks and gardens were all carefully constructed, planted, and groomed. Even the West Lake was an artificial construction. The illusion of a natural setting had to be rigorously

maintained in the thirteenth century by peasants recruited to clear and enlarge the lake, and by military patrols empowered to enforce the various prohibitions against throwing rubbish or planting lotuses or water chestnuts.[18]

What is one to make of examples, such as these, of a disregard of nature in traditional China? The author who has suggested them, Yi-Fu Tuan, calls them "discrepancies between environmental attitude and behavior." They are that, certainly. But the inference that attitudes are one thing, and behavior is something else (or, more generally, that people never live up to their ideals) skirts a number of issues. If the behavior of the builders of Changan and Hangzhou did not conform to the attitudes of Buddhism or Daoism, might it have conformed to the attitudes of some other tradition? We have already suggested that interpretation by writing of Confucianism, and of astronomers' and artists' attitudes toward nature. That still leaves the construction of such cities within the Chinese religious tradition, but it extends the behavioral possibilities of that tradition. Yi-Fu Tuan himself uses the traditional Chinese distinction between the *yin* (passive, natural, female) and the *yang* (active, artificial, male) to see city building as assertions of traditional *yang* attitudes, ideas, and ideals. If Buddhism and Daoism are *yin* religious traditions, then emperor worship, ancestor worship, Confucianism, perhaps even astronomy and military rituals can be seen as *yang* religious traditions. In that vein, there is no "discrepancy" between the *yang* religion of emperor worship and the act of moving mountains or digging lakes to build the emperor's city.

Chinese emperor worship may have played a role similar to European Christianity in sanctioning the exploitation of nature. Astronomical and artistic interpretations of Buddhism and Daoism could also serve the cause of redesigning nature. No intellectual tradition is purely naturalistic or entirely hostile to nature. But, on balance, the Chinese seem to have been more attuned to the natural world (in thought and action) than were their European contemporaries. It is difficult, for instance, to imagine the Western equivalent of the Chinese Tang dynasty emperor "who went off in the springtime with his court musicians to gladden the flowers with soft music."[19]

It is impossible to imagine the Western equivalent of an inscription in a Japanese monastery that praises the beautiful blossoms of a particular plum tree and warns: "Whoever cuts a single branch of this tree shall forfeit a finger therefor."[20] The Eastern equation of the human and the natural could redound to the disadvantage of humans as well as to the advantage of nature.

Medieval Christianity was not entirely lacking in equivalents of Eastern holy men. But the story of one, who appeared around 1200, shows more, perhaps, about the differences than the similarities of the East and West. Like a Christian Buddha, Saint Francis of Assisi led a group of monks who not only humbled themselves by giving up their possessions to live with the poor, but attempted to humble humanity by rejecting human control over nature. Legend describes Saint Francis preaching to the birds and persuading a wolf not to attack an Italian town. Saint Francis believed that animals also had souls. To him all of nature was sacred. He

Saint Francis of Assisi preaches to the birds. The Christian tradition approaches the Chinese. But even here the great florentine artist Giotto places humans in the foreground, and the birds (like the viewers of the painting) are placed at the eye level of the saint. One suspects that a Chinese artist of the period would have preferred the top half of the painting, but with the birds back in the air and trees. (Granger)

spoke of Brother Ant and Sister Fire and urged his listeners to glorify all of God's creations. He may even have believed in reincarnation; some Christians and Jews in southern France did at this time.

The challenge that Saint Francis and these others made to the Judeo-Christian tradition of dominating nature was so radical that it could not succeed. The group in southern France was suppressed violently. Pope Innocent III was able to bring Saint Francis and his disciples into the church (despite a dream that they might be able to take over) and defuse their message. In the end Francis died, the Franciscans were given a lot of money, and they became the caretakers, rather than the comrades, of the poor and the animals.

That was about as close as Christianity came to nature worship. Saint Francis could never have been a Buddha because Christianity did not even give him the vocabulary for such an extreme. It was a big step for Saint Francis to argue that animals had souls. That had never been an issue for the Hindus. They assumed all along that animals were just as divine as humans. The Buddha had been beyond that point when he struggled with the question of reincarnation. Saint Francis shows us the limits of Christianity in two ways: his views were much more moderate than those of Eastern holy men; and there was never much of a chance that he would change the direction of Christian culture. He was much too extreme for the church.

In stressing the different philosophical orientations of the East and the West, we do not mean to ignore the question of behavior. Lynn White's argument, in fact, depends on a difference between the ecological behavior of the West and that of the East. We have observed examples of ecological damage or avoidance in traditional China. Do such examples refute White's argument?

We think not. First, the damage does not seem that severe. Second, White is not arguing that monotheism is the only cause of environmentally harmful behavior; emperor worship may have had a similar effect. But most importantly, White is arguing that the Judeo-Christian separation of man and nature gave rise to a particular kind of science that has transformed the world. We must turn, then, to the rise of Western science.

THE RESPONSIBILITY OF THE WESTERN SCIENTIFIC REVOLUTION

Science certainly existed long before Christianity. In fact it took the Christians over a thousand years to recover the highly advanced science of the ancient Greeks. This knowledge had been kept relatively intact by the scholars of the Byzantine Empire in Eastern Europe and the Arab scientists in North Africa and Spain. But when, after 1200, the Christians of Europe finally regained Greek science and translated it into Latin, they approached it very differently from the way the Greeks of Byzantium and the Muslims of the Arab world did. The Byzantine Greeks saw science as symbolic communication from God. They viewed the ant as God's message to the lazy. Fire, to them, was God's way of showing the Christian how to rise to heaven. The rainbow was a symbol of hope—the sign that God sent to Noah after the forty days of rain and flood.

> However, in the Latin West by the early thirteenth century natural theology was following a very different bent. It was ceasing to be the decoding of the physical symbols of God's communication with man and was becoming the effort to understand God's mind by discovering how his creation operates. The rainbow was no longer simply a symbol of hope first sent to Noah after the Deluge: Robert Grosseteste, Friar Robert Bacon, and Theodoric of Frieberg produced startling sophisticated work on the optics of the rainbows, but they did it as a venture in religious understanding. From the thirteenth century onward, up to and including Leibnitz and Newton, every major scientist, in effect, explained his motivations in religious terms. Indeed, if Galileo had not been so expert an amateur theologian he would have gotten into far less trouble: the professionals resented his intrusion. And Newton seems to have regarded himself more as a theologian than as a scientist. It was not until the late eighteenth century that the hypotheses of God became unnecessary to many scientists.[21]

Thus, modern science began as an attempt by very religious philosophers to understand the natural world that God had created and given them. They believed that God had revealed his intentions in a number of ways. He had revealed his word in the Bible—the teachings of the Old Testament and of Jesus—and he had shown his handiwork in the planets and natural environment that he had created for human use.

The first scientific thought was motivated by the hope of understanding God rather than conquering nature. Saint Thomas Aquinas, for instance, declared:

> The Creatures upon earth were not all made, no not the most of them, for man's eating and drinking; but for his glorifying the Wisdom, Goodness and Power of his Creator in the contemplation of them.[22]

By the seventeenth century, however, the work of the first modern scientists—people like Copernicus, Galileo, Sir Francis Bacon, Descartes, and Sir Isaac Newton—had led in two ways to conclusions that Saint Thomas Aquinas and the other theologians of the Middle Ages would not have been able to accept. First, the study of nature led to an increased awareness of the difference between the natural world and human beings. Second, the Europeans who became conscious of that difference became aware of the possibilities of exploiting or controlling nature.

It may seem strange to us that people did not always realize that nature was separate from man. We are so convinced that the grass or the moon or a wooden table is apart from us that it is difficult to imagine how people could think otherwise. The fact remains, nevertheless, that we in the modern Western world make a sharper distinction between people and things, man and nature, ourselves and the things around us, than did anyone before us. It is almost as if our skins have toughened in the last couple of hundred years. They haven't of course, but

we have developed a sense of ourselves as separate individuals, operating in a world full of things, that is very recent.

Perhaps modern science has done more than anything else to separate our bodies from nature. We have already seen how earlier traditions have emphasized the community of the human and animal world. Certainly, the religion of the Jews and Christians aided the separation of the human individual from the animal world. But the scientists of the fifteenth to eighteenth centuries carried this idea of separation a lot further. Even when they were religious they thought of themselves as *observers* of a separate reality. Previously—that is, before the last five, six, or seven hundred years—almost all people imagined themselves as *participants* in, rather than observers of, nature.

The feeling of participating in, rather than looking at, nature was particularly common among the lower classes in the Middle Ages. The farming peasants, serfs, and tradespeople were usually unaware of the Christian doctrines that insisted on the separation of the human and the animal world. They were more likely to think as Saint Francis did, or they were so involved in the work of farming that they still accepted much older, Neolithic ideas about the similarity of soil and human mothers, and they personalized the rain, wind, and harvest.

Even the best-educated Christians of the Middle Ages believed that the basic elements of nature—air, earth, fire, and water—were found in varying proportions in human beings just as in the natural world. Just as a high amount of earth would account for the stability of a mountain or a chair, it would also be identified as the cause of human melancholy or laziness. The same thing that made the clouds float—an overdose of air—was thought responsible for making some people giddy or flighty. Fire might ignite the human spirit just as readily as it would a bale of hay. The same elements were found in man and beast, and even in stones and plows.

The Christians of the Middle Ages also accepted the assumptions of an astrology that may have originated locally or traveled from ancient India. The lives of human beings were thought to be just as determined by the moon and other "stars" as the seasons and the droughts and the quality of the crops.

In short, the people of medieval Europe were almost as sure of nature's power in human life as people had always been. And like earlier civilizations, they imagined that the things of the world lived very much as people did. Stones fell because they wanted to; they were attracted to the earth, or they "desired" to be reunited with other stones. The world was full of magic, and everything (including people) participated.

THE WORLD AS GARMENT OR STAGE: GALILEO

We can almost see how revolutionary modern science must have been to these people if, instead of reading the new scientific books, we look at their paintings of themselves. The paintings of the Middle Ages have no three-dimensional per-

The appeal and meaning of modern science: the eyes have it. To see is to measure and possess. How high? How far? How deep? How much? Why are none of these men looking at the woman in the tower, or at each other, or at any living thing? Were the trees cut down because they obstructed the view? Are those lines of vision latent rifle shots? No, it is only the gentlemen of the new scientific age celebrating the power of sextant, quadrant, telescope, and compass. (Deutches Museum)

spective. Crowds of people are painted on top of each other as if they occupy the same space. Angels and devils are just as real as people. Halos are just as real as heads. Suddenly, beginning in the 1300s in Italy, and later elsewhere, the artists show people and buildings in three dimensions. They seem suddenly aware that things are placed in space, that people in the foreground appear larger than people in the background because they are separated by distance. Even the rectangular shape of paintings (which we take for granted) became increasingly standardized about this time: a painting was to become like a window on the world. What had happened is that the artist had begun to view the world as an observer. He had detached himself from his surroundings and attempted to duplicate what he saw. This is exactly what the first modern scientists attempted to do. They stepped back to look

at the world—the stars or butterflies—as detached observers rather than as participants. They measured things instead of vibrating with them—and that was a revolution. By the 1600s the world had become, in Shakespeare's words, a stage; it was no longer a piece of clothing one would wrap around oneself, but a spectacle that one would observe.

All of the "discoveries" of modern science had helped bring this about. Perhaps they were not discoveries as much as they were "creations," or new ways of seeing things. To put it another way, we might say that the discoveries of individual scientists were not nearly as important as the new attitude toward the world that led them to these discoveries. The attitude of this new science—the assumption that men and nature were fundamentally different—had enormous ecological implications.

Galileo (1564–1642) is usually credited with improving the telescope, turning it on the heavens, and supporting the theory of Copernicus (1473–1543) that the earth revolved around the sun, rather than vice versa. All of this is true. But the reason that Galileo wanted to use the telescope in the first place was that he believed the planets were not living sources of light (as most of his contemporaries believed), but were instead dead balls of matter like the earth and moon.

The great achievement of European physical science (from about 1500) was that it developed a method of describing the separate physical world in terms that could not be refuted. This was because scientists such as Galileo turned their attention from all of the "subjective" features of the world to its "objective," or measurable, qualities. Instead of asking about such subjective qualities as the "hopefulness" of rain, they measured the rainfall. Instead of asking about the taste or sound or smell of an object, they asked about its size, shape, or rate of motion. They focused, in short, on those qualities of an object that could be measured because measurements were not open to interpretation. Anyone could disagree about the "meaning" of a falling object. There might even be different interpretations about the sound that such an object made as it struck the ground. But no one could disagree about its rate of motion, once that had been computed. The value of science was that its results were indisputable.

The problem with science (from an ecological point of view) was that the human, or "subjective," element had to be overlooked so that the objective qualities could be understood. The result of the scientific approach was to see the objects of the natural world as if they were dead. See how Galileo explains his method:

> As soon as I form a conception of an object, I immediately feel the necessity of seeing that it has boundaries of some shape or other; that relative to others it is great or small; that it is in this or that place, in this or that time; that it is in motion or at rest; that it touches, or does not touch, another body. . . . But I do not find myself absolutely compelled to determine if it is white or red, bitter or sweet, sonorous or silent, smelling sweetly or disagreeably. . . . Therefore I think that these tastes, smells, colors, etc., with regard to the

> object in which they appear to reside, are nothing more than mere names. They exist only in the observer. . . . I do not believe that there exists anything in external bodies for exciting tastes, smells, and sounds, etc., except size, shape, quantity, and motion.[23]

In our terms, Galileo had concluded that only the "primary qualities" (those which could be measured) existed. The secondary qualities, which could not easily be measured, did not exist. This has been a tendency in modern science ever since. The scientist is concerned with providing exact information. In attempting to be exact, he or she singles out the impersonal, "objective," or quantitative qualities of the object under investigation. That is the only way that measurement is possible. But it means divorcing these measurable qualities from the total organic context of the object.

Let us take the case of butterflies. We can appreciate butterflies for their beauty, their colors, or their grace—or we can attempt to understand them. The job of science is understanding. The process of understanding something like butterflies requires that we ask questions that can be answered: How large do they come, what different types are there, how fast do they fly, and how do they stay aloft? These are all questions that can be answered objectively because they require only that we make certain measurements and computations. We do not ask which butterflies are beautiful because there is no way of measuring that, no way of getting an objective answer.

The job of the scientist can be very useful—even ecologically. We might, for instance, want to know about the different types of butterflies in order to replenish an endangered species. The problem is that the more we become preoccupied with measuring and counting, the less we see natural objects in their totality. We are speaking only of a tendency in science—but the tendency is very real. One tendency of science is to isolate and abstract the qualities of an object that can be measured—to treat such qualities as if they were divorced from the total object. But these are not only the conditions of orderly scientific research, they are also the conditions under which organisms die. Try to weigh and measure a live butterfly.

Modern science has enabled us to understand our world because it has simplified complex organic processes so that they conform to mechanical laws. Galileo and Newton were able to tell us much about the acceleration of bodies by treating moving things as "bodies," whether they be people or animals or balls or meteorites. When you are studying movement, everything that moves is equal. The scientists of the seventeenth and eighteenth centuries could tell us so much about the motion of the planets and the objects of the earth by imagining that both behaved as so many Ping-Pong or billiard balls. This was a way of simplifying problems of weight, mass, and matter. The answers that science has gained are of invaluable assistance. Such answers were impossible with the medieval assumption that even planets and rocks behaved of their own will or inclination. No science

was possible as long as people treated the rocks and planets as if they acted by whim. Science appropriated the whim and the will of natural forces with its mechanical laws, and those laws were used in Christian culture to give "dominion over the fish of the sea, and over the birds of the heavens, and over every living thing that moveth upon the earth."

SCIENCE, SCIENCE, EVERYWHERE

The scientific revolution that occurred in Western Europe between 1300 and 1700 has since transformed the world. It is the root of the science taught in all of the schools and universities of the world. There is no other. There is no Chinese as opposed to Muslim or Christian science. This is because all scientists are involved in the same enterprise of explaining how the natural world works. All are involved in the scientific process of observation, experimentation, and the development and evaluation of explanatory theories. They may sometimes champion different theories; but when they do, the process of science itself helps resolve their differences. This is the value of science, and the reason there is only one. It works. Ultimately the scientific method and the community of scientists can resolve any differences and come to a generally accepted conclusion because the overarching commitment of science is to "the truth" about the natural world.

We have seen that the truth that is obtained by science is the truth about a separate reality—that is, a reality separate from the human observer. The scientific revolution that we have discussed depended on a conceptual revolution that allowed people to observe nature as a separate reality. We have argued that that conceptual revolution occurred first in the West because the Judeo-Christian tradition provided the necessary framework. Judaic monotheism posited a creator God separate from his creation. Judaism also said that God gave humans the natural world to exploit. Perhaps more significant, however, was the way in which Christianity changed Judaism. By making its appeal universal, rather than tribal, it made belief more important than membership. Christianity was, and is, a very theological religion. It is rich in doctrines, dogmas, and beliefs, as well as in a history of heretics. You can be born a Jew, but you have to believe to be a Christian. It is that combination of monotheism and the stress on theology, beliefs, explanations, or "truth" that made the conceptual breakthrough to modern science a Christian event, rather than, say, a Muslim one.

Muslim scientific knowledge was considerably greater than the Christian in the period between 900 and 1400. Ibn al-Haytham (965–1030) of Basra made major contributions in optics, astronomy, and mathematics that would not be improved on in Europe for seven centuries. Muslim medicine was renowned. Muhammad al-Razi (860–940) wrote a medical encyclopedia that was used in Europe into the fifteenth century. He identified smallpox and measles, and was the first to use alcohol as an antiseptic and mercury as a purgative. Ibn Sina (Avicenna in Latin,

980–1037) read entire libraries and wrote on virtually every subject. His medical encyclopedia constituted half the medical curriculum at European universities through the fifteenth century. That Islam did not initiate the breakthrough to modern science, despite these achievements and despite its insistent monotheism, is puzzling. What Islam lacked, according to one modern Muslim scholar,[24] was Christianity's obsession with theology, finding out, beliefs. It was, perhaps, that obsession that made the conceptual revolution of modern science (as well as later secularization) easier. Islamic literature concentrated not so much on attempting to understand, but on experiencing and loving God.

Chinese thought was directed more to understanding. During the Song dynasty, Chinese painting was vividly naturalistic, almost scientific in detail; Confucian philosophers like Zhu Xi had urged "seeking for principle in everything." Neo-Confucianism, like Confucianism, was more interested in the human realm than in a separate world of nature, and while it was not monotheistic it was also not religious.

After the Mongol invasion and during the Ming dynasty (1368–1644) the confident, socially responsible, neo-Confucianism of the Song declined with a general drop in productivity, innovation, and expansion. Buddhist and Daoist thinkers seemed to have more to say in uncertain times. The sixteenth-century alternative to neo-Confucianism was, perhaps, the moral intuitionism of Wang Yangming. According to Wang, nature was only a part of human consciousness. It had no other existence. "Outside the mind," he said, "there are no principles. Outside the mind there are no phenomena."[25]

This turn inward, away from the natural world, occurred also in Chinese painting of the period. The earlier naturalistic style of the Song was abandoned in the Ming by subjective and introspective images. "The new emphasis on Mind," the historian Mark Elvin has written, "devalued the philosophical significance of scientific research by draining the reality from the world of sensory experience."[26] Instead of developing mechanical and quantitative models in order to understand an outside reality, Chinese philosophers and scientists sought an intuitive communion with the mind.

It is instructive to compare the deductions of one of the great Chinese scientists of the seventeenth century with those of one of the great Europeans. Fang Yizhi [Fang I-Chih] (1611–1671) was a leader of the Chinese encyclopedic tradition. A neo-Confucian scholar and official, Fang Yizhi was swept up in the chaos of the seventeenth-century peasant uprisings, the Manchu invasion and bandit raids, and the collapse of the Ming. Like many intellectuals of his age, he sought solace in Buddhism and took refuge as a monk after 1650. His *Brief Record of the Principles of Things* (1664) dealt with such topics as astronomy, anatomy, botany, zoology, and physics. He was critical of his predecessors, asked questions about scientific method, and conducted experiments. He debated the Jesuit missionaries in China while accepting many of their insights. He understood the circulation of blood and the nature of eclipses.

On the central issue of Chinese intellectuals, the investigation of things, Fang Yizhi was more of a materialist than many of his contemporaries. Contrary to Wang Yangming, Fang urged his readers to accept the existence of things, to know specific things in detail, and to learn to manipulate things for human benefit.[27] But, perhaps especially after his Buddhist withdrawal in 1650, Fang Yizhi was more concerned with "general principles" than with specifics, and he thought that these general principles could be gained intuitively rather than through analytical, quantitative, or experimental method. The problem with Western science, Fang wrote (on the basis of his contacts with the Jesuits), was that they "use a variety of techniques for their swift computations, but they are still out of touch with general principles."[28] General principles were spiritual. They existed in the mind, not in the material world, according to Fang. Ultimately for Fang the specific things, the empirical reality, the objects of scientific study in the West, were unknowable. "Since it is only the mind which knows and perceives," he wrote, "everything is shadows and echoes."[29]

In a famous formulation of much the same problem, but one that led to a radically different conclusion, René Descartes (1596–1650) wrote in his *Discourse on Method* (1637), "I think, therefore I am." For Descartes the existence of mind was proof not that everything is shadows and echoes but that the material things of the world exist. The French philosopher said he tried to doubt everything but that even by doing so he had to admit his own existence as the doubter or thinker. Then, he concluded, since he could not doubt his own existence, he could also not doubt that there was something greater than himself. He, after all, was imperfect because he doubted. He did not know everything.

Descartes was both a Christian theologian and a scientist, both medieval and modern. Ultimately, his reason for accepting the reality of the world as more than a figment of his imagination is that God would not deceive him by giving him ideas that had no relation to reality. For the Christian the separate reality exists, and God has given humans the reason with which to understand it. The Buddhist belief that the world is fundamentally shadows and echoes was not an option.

SCIENCE AND ECOLOGY

We are led then to a difficult question. Can we have Christian science and Buddhist ecology too? Are the achievements of science necessarily destructive to the environment? Are the goals of science and ecology necessarily at odds? Do we have to choose between scientific progress and environmental well-being?

Perhaps our only response can be to try to have the best of both worlds. We know that science can be an effective instrument, as Fang Yizhi said for human welfare. Science is our problem-solving tool. Science can be applied to environmental problems as easily as to any others. We have also learned, however, that the process of distancing, distinguishing, abstracting, and analyzing that is part of

science can obscure deeper organic connections—perhaps what Fang Yizhi meant by general principles. It would seem wise, then, to keep in mind both tendencies of science (alienating and liberating) so that we can use it most effectively and for the greatest good.

FOR FURTHER READING

Lynn White's "The Historical Roots of Our Ecologic Crisis" is reprinted in *Ecology and Religion in History,* edited by David and Eileen Spring, in Robert Detweiler's *Environmental Decay in Its Historical Context,* and in *Western Man and Environmental Ethics,* edited by Ian Barbour, all of which have other good articles. The contrast between Christian and Eastern attitudes toward nature is discussed both more theoretically and more popularly in Alan W. Watts's *Nature, Man and Woman.* But the grand interpretive synthesis on the Christian background of Western technology is Lewis Mumford's marvelous history *Technics and Civilization.*

To understand the medieval Christian attitudes toward nature, one normally thinks of histories of science and of philosophy. There are many good books on each. Perhaps the best history of science is Stephen Toulmin and June Goodfield's *The Fabric of the Heavens* on astronomy, their *Architecture of Matter* on physics, and their *The Discovery of Time* on history and geology. For more attention to medieval science, there is A. C. Crombie's *Medieval and Early Modern Science,* Charles Singer's *From Magic to Science,* and M. Clagett's *The Science of Mechanics in the Middle Ages.* Similarly for medieval philosophy, there is E. Gilson's *History of Christian Philosophy in the Middle Ages,* Gordon Leff's *Medieval Thought,* H. O. Taylor's *The Medieval Mind,* Maurice De Wulf's *Philosophy and Civilization in the Middle Ages,* F. B. Artz's *The Mind of the Middle Ages,* and F. C. Copleston's *Medieval Philosophy.*

Almost all of these books, however, concentrate on the discoveries and innovations of intellectuals, leaving the attitudes of most people and even the unchanging assumptions of the intellectuals between the lines. Thus, the tenor of the medieval attitude toward nature might be better understood with a book like C. S. Lewis's *Discarded Image* or (equally superb and unconventional) Owen Barfield's *Saving the Appearances.* Another is Arthur O. Lovejoy's classic *The Great Chain of Being,* or E. M. W. Tillyard's *The Elizabethan World Picture* for a slightly later period. Equally useful is the first chapter of William J. Brandt's *The Shape of Medieval History: Studies in Modes of Perception.* Two other previously mentioned classics should also be indicated in this regard. They are J. Huizinga's *The Waning of the Middle Ages* and Lynn White, Jr.'s *Medieval Technology and Social Change.*

For those interested in the comparison with Asian civilization, the same advice is in order. Joseph Needham's multivolume *Science and Civilization in China* is a compendium of insight and information. It is invaluable for comparisons with Western civilization. But the introductory student might better understand the Asian attitude toward nature with Joseph Campbell's *The Masks of God: Oriental Mythology,* Frederick W. Mote's *Intellectual Foundations of China,* or even Hermann Hesse's *Siddhartha. The Book of Mencius* is a classic that includes references to wastefulness in energy use, conservation, food storage, and flood control. Leon E. Stover's *The Control Ecology of Chinese Civilization: Peasants and Elites in the Last of the Agrarian States* is a demanding modern account.

Among the more readable introductions to the conceptual revolution of modern science are Herbert Butterfield's *The Origins of Modern Science,* Arthur Koestler's *The Sleepwalkers,* and the Toulmin and Goodfield volumes mentioned above. More theoretical and challenging approaches are E. A. Burtt's *The Metaphysical Foundations of Modern Science* and Thomas S. Kuhn's *The Structure of Scientific Revolutions.* For a more thorough history there is Charles C. Gillispie's *The Edge of Objectivity* and A. R. Hall's *The Scientific Revolution, 1500–1800.*

There are, of course, many other ways of approaching the subject of ecology—even in the time period we have chosen. Sometimes, in fact, the most innovative and interesting books are those that ignore traditional chronological, geographical, and even topical boundaries. One thinks first of Fernand Braudel's *The Mediterranean and the Mediterranean World in the Age of Philip II.* The first half of the first volume of this masterpiece discusses the role of the environment in ways that might serve as a model for future works on other areas and other times. Another monumental starting point for the history of ecology is Emmanuel Le Roy Ladurie's *Times of Feast, Times of Famine: A History of Climate Since the Year 1000.* The subject of ecology can also be approached from the perspective of the single world ecological system that has been emerging in the last five hundred years. *The Columbian Exchange: Biological and Cultural Consequences of 1492* by Alfred W. Crosby, Jr., begins this study in a most engaging and readable way. Finally, for a very tentative overview of human ecology throughout human history we should note the introductory *Man and Nature: An Anthropological Essay in Human Ecology* by Richard A. Watson and Patty Jo Watson, and Edward Hyams's *Soil and Civilization.*

NOTES

1. Arnold Toynbee, "The Religious Background of the Present Environmental Crisis," *International Journal of Environmental Studies* 3 (1972), pp. 141–146. Reprinted in *Ecology and Religion in History,* eds. David and Eileen Spring (New York: Harper & Row, 1974), p. 146.
2. *Ibid.,* pp. 142–143.
3. Spring, *op. cit.,* pp. 4–5. Lynn White's account is in "Continuing the Conversation," in *Western Man and Environmental Ethics,* ed. Ian Barbour (Reading, Mass.: Addison Wesley, 1973), p. 55.
4. Lynn White, Jr., "The Historical Roots of Our Ecologic Crisis," in Spring, *op. cit.,* pp. 19–20.
5. *Ibid.,* pp. 22–23.
6. Paul Bohannan and Philip Curtin, *Africa and the Africans,* rev. ed. (New York: Natural History Press, 1971), p. 173.
7. Quoted in John S. Mbiti, "African Religion and Its Contribution to World Order," *Whole Earth Papers,* n.d. no. 16, p. 31.
8. Ake Hultkrantz, *The Religions of the American Indians,* trans. Monica Setterwall (Berkeley: University of California Press, 1979), p. 15.
9. J. Mooney, "The Ghost-Dance Religion and the Sioux Outbreak of 1890," *Annual Report of the Bureau of American Ethnology,* 1896, 14, no. 2, p. 721. Quoted in Hultkrantz, *op. cit.,* p. 54.
10. Christopher Vecsey, "American Indian Environmental Religions," in *American Indian*

Environments: Ecological Issues in Native American History, eds. Christopher Vecsey and Robert W. Venables (Syracuse: Syracuse University Press, 1980), pp. 8–37.
11. *Ibid.,* p. 21.
12. *Ibid.*
13. This argument is made by Calvin Martin in *Keepers of the Game: Indian-Animal Relationships and the Fur Trade* (Berkeley: University of California Press, 1978).
14. From *Sutrakratanga,* I:1–3. Adapted from *Sources of Indian Tradition,* vol 11., ed. William Theodore de Bary (New York: Columbia University Press, 1958), p. 57.
15. Adapted from de Bary, *op. cit.,* p. 359.
16. Mark Elvin, *The Pattern of the Chinese Past* (Stanford: Stanford University Press, 1973), p. 129.
17. Quoted in Yi-Fu Tuan, "Discrepancies Between Environmental Attitude and Behaviour: Examples from Europe and China," *Canadian Geographer,* 12, no. 3 (1968). Quoted in Spring, *op. cit.,* p. 107.
18. *Ibid.,* p. 93.
19. Kakuzo Okakura, *The Book of Tea* (New York: Dover, 1964), p. 54. Okakura's charming little introduction to the Orient was first published in 1906.
20. *Ibid.*
21. Quoted in Spring, *op. cit.,* pp. 26–27.
22. Quoted in Ernest L. Tuveson, *Millennium and Utopia* (Berkeley: University of California Press, 1949), p. 84.
23. Adapted from Lewis Mumford, *Technics and Civilization* (New York: Harcourt Brace Jovanovich, 1962), p. 49.
24. Fazlur Rahman, *Islam and Modernity* (Chicago: University of Chicago Press, 1982).
25. Quoted in Elvin, *op. cit.,* p. 226.
26. *Ibid.,* pp. 226–227.
27. Willard J. Peterson, "Fang I-Chih: Western Learning and the 'Investigation of Things'," in *The Unfolding of Neo-Confucianism,* ed. William Theodore de Bary (New York: Columbia University Press, 1970), p. 379.
28. Quoted in Elvin, *op. cit.,* p. 231.
29. *Ibid.,* p. 232.

Chronological Table of The Traditional World

500–1500

Europe	Middle East and Africa	China	Japan
Barbarian invasions 300–600			
Constantinople counters barbarians with heavy cavalry 300–600			
Justinian 527–565			Late Yamato perio 552–710
Byzantine "theme system" under Heraclius 610–641	Muhammad 570–632	Sui dynasty 589–618	Importation of Buddhism and Chinese civilization 550–800
Development of cavalry in West 600–900	Hegira 622	Tang dynasty 618–907	
Battle of Tours, Muslims contained to Spain 733	Muslim expansion 632–738 Umayyad Caliphate 661–750	Height of Changan Eighth century	
Coronation of Charlemagne 800		Li Bo 701–762	Nara period 710–784
	Abbasid Caliphate 750–932		Heian period at Kyōto 794–1185
Viking invasions 793–1066	Buyids replace Abbasids 932–1062		

c. = circa (about) *d. = died* *f. = founded* *r. = ruled*

(continued