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# Environmental Philosophy

## *From Animal Rights to Radical Ecology*

THIRD EDITION

Michael E. Zimmerman
J. Baird Callicott
George Sessions
Karen J. Warren
John Clark

# ENVIRONMENTAL PHILOSOPHY

## From Animal Rights to Radical Ecology

## THIRD EDITION


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Prentice Hall

Upper Saddle River, New Jersey 07458

*Library of Congress Cataloging-in-Publication Data*

Environmental philosophy : from animal rights to radical ecology / general editor Michael E. Zimmerman ; associate editors J. Baird Callicott . . . [et al.].—3rd ed.
p. cm.
Includes bibliographical references.
ISBN 0-13-028913-2
1. Human ecology—Philosophy. 2. Environmental ethics. I. Zimmerman, Michael E., (date)– II. Callicott, J. Baird

GF21.E56 2001
179'.1—dc21

00-063713

Acquisition Editor: Ross Miller
Editorial Assistant: Carla Worner
Production Editor: Jean Lapidus
Prepress and Manufacturing Buyer: Sherry Lewis
Copy Editor: Stephen C. Hopkins
Cover Design: Joseph Sengotta
Cover Art: Jacqueline Bishop, "Imaginary Nest," 1995.
Oil on panel. Reprinted by permission of the artist.

This book was set in 10/12 New Baskerville by Publications Development Company of Texas and was printed and bound by RR Donnelley & Sons Company.
The cover was printed by Phoenix Color Corporation.



A Division of Pearson Education
Upper Saddle River, New Jersey 07458



Printed in the United States of America
10 9 8 7 6 5 4 3 2 1

ISBN 0-13-028913-2

PRENTICE-HALL INTERNATIONAL (UK) LIMITED, *LONDON*
PRENTICE-HALL OF AUSTRALIA PTY. LIMITED, *SYDNEY*
PRENTICE-HALL CANADA INC., *TORONTO*
PRENTICE-HALL HISPANOAMERICANA, S.A., *MEXICO*
PRENTICE-HALL OF INDIA PRIVATE LIMITED, *NEW DELHI*
PRENTICE-HALL OF JAPAN, INC., *TOKYO*
PEARSON EDUCATION ASIA PTE. LTD., *SINGAPORE*
EDITORA PRENTICE-HALL DO BRASIL, LTDA., *RIO DE JANEIRO*

ıeral editor
—3rd ed.

ımerman, Michael E.,

00-063713

Company of Texas

# Contents

: Indiana University Press,

ington: Indiana University

and Peace: Seeing Connec-
*Nature*, ed. Karen J. Warren
Press, 1–15.
*ture*. Bloomington: Indiana

# THE DEATH OF NATURE

*Carolyn Merchant*

Carolyn Merchant is a professor of environmental history, philosophy, and ethics in the department of conservation and resource studies at the University of California at Berkeley. She is the author of numerous publications on feminism and the environment, including *The Death of Nature: Women, Ecology and the Scientific Revolution* and *Ecological Revolutions*.

## INTRODUCTION: WOMEN AS NATURE

Women and nature have an age-old association—an affiliation that has persisted throughout culture, language, and history. Their ancient interconnections have been dramatized by the simultaneity of two recent social movements—women's liberation, symbolized in its controversial infancy by Betty Friedan's *Feminine Mystique* (1963), and the ecology movement, which built up during the 1960s and finally captured national attention on Earth Day, 1970. Common to both is an egalitarian perspective. Women are struggling to free themselves from cultural and economic contraints that have kept them subordinate to men in American society. Environmentalists, warning us of the irreversible consequences of continuing environmental exploitation, are developing an ecological ethic emphasizing the interconnectedness between people and nature. Juxtaposing the goals of the two movements can suggest new values and social structures, based not on the domination of women and nature as resources but on the full expression of both male and female talent and on the maintenance of environmental integrity.

New social concerns generate new intellectual and historical problems. Conversely, new interpretations of the past provide perspectives on the present and hence the power to change it. Today's feminist and ecological consciousness can be used to examine the historical interconnections between

Excerpted by Karen J. Warren from *The Death of Nature*, originally published by Harper & Row (New York, 1980). Reprinted with permission of HarperCollins Publishers, Inc.

women and nature that developed as the modern scientific and economic world took form in the sixteenth and seventeenth centuries—a transformation that shaped and pervades today's mainstream values and perceptions.

The ancient identity of nature as a nurturing mother links women's history with the history of the environment and ecological change. The female earth was central to the organic cosmology that was undermined by the Scientific Revolution and the rise of a market-oriented culture in early modern Europe. The ecology movement has reawakened interest in the values and concepts associated historically with the premodern organic world. The ecological model and its associated ethics make possible a fresh and critical interpretation of the rise of modern science in the crucial period when our cosmos ceased to be viewed as an organism and became instead a machine.

In investigating the roots of our current environmental dilemma and its connections to science, technology, and the economy, we must reexamine the formation of a world view and a science that, by reconceptualizing reality as a machine rather than a living organism, sanctioned the domination of both nature and women.

## NATURE AS FEMALE

The world we have lost was organic. From the obscure origins of our species, human beings have lived in daily, immediate, organic relation with the natural order for their sustenance. In 1500, the daily interaction with nature was still structured for most Europeans, as it was for other peoples, by close-knit, cooperative, organic communities.

Thus it is not surprising that for sixteenth-century Europeans the root metaphor binding together the self, society, and the cosmos was that of an organism. As a projection of the way people experienced daily life, organismic theory emphasized interdependence among the parts of the human body, subordination of individual to communal purposes in family, community, and state, and vital life permeating the cosmos to the lowliest stone.

The idea of nature as a living organism had philosophical antecedents in ancient systems of thought, variations of which formed the prevailing ideological framework of the sixteenth century. The organismic metaphor, however, was immensely flexible and adaptable to varying contexts, depending on which of its presuppositions was emphasized. A spectrum of philosophical and political possibilities existed, all of which could be subsumed under the general rubric of *organic.*

Central to the organic theory was the identification of nature, especially the earth, with a nurturing mother: A kindly beneficent female who provided for the needs of mankind in an ordered, planned universe. But another opposing image of nature as female was also prevalent: wild and uncontrollable nature that could render violence, storms, droughts, and general chaos. Both were identified with the female sex and were projections of human perceptions onto

the external world. The metaphor of the earth as a nurturing mother was gradually to vanish as a dominant image as the Scientific Revolution proceeded to mechanize and to rationalize the world view. The second image, nature as disorder, called forth an important modern idea, that of power over nature. Two new ideas, those of mechanism and of the domination and mastery of nature, became core concepts of the modern world. An organically oriented mentality in which female principles played an important role was undermined and replaced by a mechanically oriented mentality that either eliminated or used female principles in an exploitative manner. As Western culture became increasingly mechanized in the 1600s, the female earth and virgin earth spirit were subdued by the machine.[1]

The change in controlling imagery was directly related to changes in human attitudes and behavior toward the earth. Whereas the nurturing earth image can be viewed as a cultural constraint restricting the types of socially and morally sanctioned human actions allowable with respect to the earth, the new images of mastery and domination functioned as cultural sanctions for the denudation of nature. Society needed these new images as it continued the processes of commercialism and industrialization, which depended on activities directly altering the earth—mining, drainage, deforestation, and assarting (grubbing up stumps to clear fields). The new activities utilized new technologies—lift and force pumps, cranes, windmills, geared wheels, flap valves, chains, pistons, treadmills, under- and overshot watermills, fulling mills, flywheels, bellows, excavators, bucket chains, rollers, geared and wheeled bridges, cranks, elaborate block and tackle systems, worm, spur, crown, and lantern gears, cams and eccentrics, ratchets, wrenches, presses, and screws in magnificent variation and combination.

These technological and commercial changes did not take place quickly; they developed gradually over the ancient and medieval eras, as did the accompanying environmental deterioration. Slowly over many centuries early Mediterranean and Greek civilization had mined and quarried the mountainsides, altered the forested landscape, and overgrazed the hills. Nevertheless, technologies were low level, people considered themselves parts of a finite cosmos, and animism and fertility cults that treated nature as sacred were numerous. Roman civilization was more pragmatic, secular, and commercial and its environmental impact more intense. Yet Roman writers such as Ovid, Seneca, Pliny, and the Stoic philosophers openly deplored mining as an abuse of their mother, the earth. With the disintegration of feudalism and the expansion of Europeans into new worlds and markets, commercial society began to have an accelerated impact on the natural environment. By the sixteenth and seventeenth centuries, the tension between technological development in the world of action and the controlling organic images in the world of the mind had become too great. The old structures were incompatible with the new activities.

Both the nurturing and domination metaphors had existed in philosophy, religion, and literature. The idea of dominion over the earth existed

in Greek philosophy and Christian religion; that of the nurturing earth, in Greek and other pagan philosophies. But, as the economy became modernized and the Scientific Revolution proceeded, the dominion metaphor spread beyond the religious sphere and assumed ascendancy in the social and political spheres as well. These two competing images and their normative associations can be found in sixteenth-century literature, art, philosophy, and science.

The image of the earth as a living organism and nurturing mother had served as a cultural constraint restricting the actions of human beings. One does not readily slay a mother, dig into her entrails for gold or mutilate her body, although commercial mining would soon require that. As long as the earth was considered to be alive and sensitive, it could be considered a breach of human ethical behavior to carry out destructive acts against it. For most traditional cultures, minerals and metals ripened in the uterus of the Earth Mother, mines were compared to her vagina, and metallurgy was the human hastening of the birth of the living metal in the artificial womb of the furnace—an abortion of the metal's natural growth cycle before its time. Miners offered propitiation to the deities of the soil and subterranean world, performed ceremonial sacrifices, and observed strict cleanliness, sexual abstinence, and fasting before violating the sacredness of the living earth by sinking a mine. Smiths assumed an awesome responsibility in precipitating the metal's birth through smelting, fusing, and beating it with hammer and anvil; they were often accorded the status of shaman in tribal rituals and their tools were thought to hold special powers.

The Renaissance image of the nurturing earth still carried with it subtle ethical controls and restraints. Such imagery found in a culture's literature can play a normative role within the culture. Controlling images operate as ethical restraints or as ethical sanctions—as subtle "oughts" or "ought-nots." Thus as the descriptive metaphors and images of nature change, a behavioral restraint can be changed into a sanction. Such a change in the image and description of nature was occurring during the course of the Scientific Revolution.

## DOMINION OVER NATURE: FRANCIS BACON'S PHILOSOPHY

Francis Bacon (1561–1626), a celebrated "father of modern science," transformed tendencies already extant in his own society into a total program advocating the control of nature for human benefit. Melding together a new philosophy based on natural magic as a technique for manipulating nature, the technologies of mining and metallurgy, the emerging concept of progress and a patriarchal structure of family and state, Bacon fashioned a new ethic sanctioning the exploitation of nature.

Bacon has been eulogized as the originator of the concept of the modern research institute, a philosopher of industrial science, the inspiration behind

the Royal Society (1660), and as the founder of the inductive method by which all people can verify for themselves the truths of science by the reading of nature's book.[2] But from the perspective of nature, women, and the lower orders of society emerges a less favorable image of Bacon and a critique of his program as ultimately benefiting the middle-class male entrepreneur. Bacon, of course, was not responsible for subsequent uses of his philosophy. But, because he was in an extremely influential social position and in touch with the important developments of his time, his language, style, nuance, and metaphor become a mirror reflecting his class perspective.

Sensitive to the same social transformations that had already begun to reduce women to psychic and reproductive resources, Bacon developed the power of language as political instrument in reducing female nature to a resource for economic production. Female imagery became a tool in adapting scientific knowledge and method to a new form of human power over nature. The "controversy over women" and the inquisition of witches—both present in Bacon's social milieu—permeated his description of nature and his metaphorical style and were instrumental in his transformation of the earth as a nurturing mother and womb of life into a source of secrets to be extracted for economic advance.

Much of the imagery Bacon used in delineating his new scientific objectives and methods derives from the courtroom, and, because it treats nature as a female to be tortured through mechanical inventions, strongly suggests the interrogations of the witch trials and the mechanical devices used to torture witches.

The new man of science must not think that the "inquisition of nature is in any part interdicted or forbidden." Nature must be "bound into service" and made a "slave," put "in constraint" and "molded" by the mechanical arts. The "searchers and spies of nature" are to discover her plots and secrets.[3]

This method, so readily applicable when nature is denoted by the female gender, degraded and made possible the exploitation of the natural environment. As woman's womb had symbolically yielded to the forceps, so nature's womb harbored secrets that through technology could be wrested from her grasp for use in the improvement of the human condition:

> There is therefore much ground for hoping that there are still laid up in the womb of nature many secrets of excellent use having no affinity or parallelism with anything that is now known . . . only by the method which we are now treating can they be speedily and suddenly and simultaneously presented and anticipated.[4]

Bacon transformed the magical tradition by calling on the need to dominate nature not for the sole benefit of the individual magician but for the good of the entire human race. Through vivid metaphor, he transformed the magus from nature's servant to its exploiter, and nature from a teacher to a slave. Bacon argued that it was the magician's error to consider art (technology) a mere "assistant to nature having the power to finish what nature has

begun" and therefore to despair of ever "changing, transmuting, or fundamentally altering nature."[5]

The natural magician saw himself as operating within the organic order of nature—he was a manipulator of parts within that system, bringing down the heavenly powers to the earthly shrine. Agrippa . . . had begun to explore the possibility of ascending the hierarchy to the point of cohabiting with God. Bacon extended this idea to include the recovery of the power over nature lost when Adam and Eve were expelled from paradise.

Due to the Fall from the Garden of Eden (caused by the temptation of a woman), the human race lost its "dominion over creation." Before the Fall, there was no need for power or dominion, because Adam and Eve had been made sovereign over all other creatures. In this state of dominion, mankind was "like unto God." While some, accepting God's punishment, had obeyed the medieval strictures against searching too deeply into God's secrets, Bacon turned the constraints into sanctions. Only by "digging further and further into the mine of natural knowledge" could mankind recover that lost dominion. In this way, "the narrow limits of man's dominion over the universe" could be stretched "to their promised bounds."[6]

Although a female's inquisitiveness may have caused man's fall from his God-given dominion, the relentless interrogation of another female, nature, could be used to regain it. As he argued in *The Masculine Birth of Time,* "I am come in very truth leading you to nature with all her children to bind her to your service and make her your slave." "We have no right," he asserted, "to expect nature to come to us." Instead, "Nature must be taken by the forelock, being bald behind." Delay and subtle argument "permit one only to clutch at nature, never to lay hold of her and capture her."[7]

Nature existed in three states—at liberty, in error, or in bondage.

> She is either free and follows her ordinary course of development as in the heavens, in the animal and vegetable creation, and in the general array of the universe; or she is driven out of her ordinary course by the perverseness, insolence, and forwardness of matter and violence of impediments, as in the case of monsters; or lastly, she is put in constraint, molded, and made as it were new by art and the hand of man; as in things artificial.[8]

The first instance was the view of nature as immanent self-development, the nature naturing herself of the Aristotelians. This was the organic view of nature as a living, growing, self-actualizing being. The second state was necessary to explain the malfunctions and monstrosities that frequently appeared and that could not have been caused by God or another higher power acting on his instruction. Since monstrosities could not be explained by the action of form or spirit, they had to be the result of matter acting perversely. Matter in Plato's *Timaeus* was recalcitrant and had to be forcefully shaped by the demiurge. Bacon frequently described matter in female imagery, as a "common harlot." "Matter is not devoid of an appetite and inclination to dissolve the world and

fall back into the old Chaos." It therefore must be "restrained and kept in order by the prevailing concord of things." "The vexations of art are certainly as the bonds and handcuffs of Proteus, which betray the ultimate struggles and efforts of matter."[9]

The third instance was the case of art (techné)—man operating on nature to create something new and artificial. Here "nature takes orders from man and works under his authority." Miners and smiths should become the model for the new class of natural philosophers who would interrogate and alter nature. They had developed the two most important methods of wresting nature's secrets from her, "the one searching into the bowels of nature, the other shaping nature as on an anvil." "Why should we not divide natural philosophy into two parts, the mine and the furnace?" For "the truth of nature lies hid in certain deep mines and caves," within the earth's bosom. Bacon, like some of the practically minded alchemists, would "advise the studious to sell their books and build furnaces" and, "forsaking Minerva and the Muses as barren virgins, to rely upon Vulcan."[10]

The new method of interrogation was not through abstract notions, but through the instruction of the understanding "that it may in very truth dissect nature." The instruments of the mind supply suggestions, those of the hand give motion and aid the work. "By art and the hand of man," nature can then be "forced out of her natural state and squeezed and molded," In this way, "human knowledge and human power meet as one."[11]

Here, in bold sexual imagery, is the key feature of the modern experimental method—constraint of nature in the laboratory, dissection by hand and mind, and the penetration of hidden secrets—language still used today in praising a scientist's "hard facts," "penetrating mind," or the "thrust of his argument." The constraints against penetration in *Natura*'s lament over her torn garments of modesty have been turned into sanctions in language that legitimates the exploitation and "rape" of nature for human good.

Scientific method, combined with mechanical technology, would create a "new organon," a new system of investigation, that unified knowledge with material power. The technological discoveries of printing, gunpowder, and the magnet in the fields of learning, warfare, and navigation "help us to think about the secrets still locked in nature's bosom." "They do not, like the old, merely exert a gentle guidance over nature's course; they have the power to conquer and subdue her, to shake her to her foundations." Under the mechanical arts, "nature betrays her secrets more fully . . . than when in enjoyment of her natural liberty."[12]

Mechanics, which gave man power over nature, consisted in motion; that is, in "the uniting or disuniting of natural bodies." Most useful were the arts that altered the materials of things—"agriculture, cookery, chemistry, dying, the manufacture of glass, enamel, sugar, gunpowder, artificial fires, paper, and the like." But in performing these operations, one was constrained to operate within the chain of causal connections; nature could "not be commanded

except by being obeyed." Only by the study, interpretation, and observation of nature could these possibilities be uncovered; only by acting as the interpreter of nature could knowledge be turned into power. Of the three grades of human ambition, the most wholesome and noble was "to endeavor to establish and extend the power and dominion of the human race itself over the universe." In this way "the human race [could] recover that right over nature which belongs to it by divine bequest."[13]

The interrogation of witches as a symbol for the interrogation of nature, the courtroom as a model for its inquisition, and torture through mechanical devices as a tool for the subjugation of disorder were fundamental to the scientific method as power. For Bacon . . . , sexual politics helped to structure the nature of the empirical method that would produce a new form of knowledge and a new ideology of objectivity seemingly devoid of cultural and political assumptions.

Human dominion over nature, an integral element of the Baconian program, was to be achieved through the experimental "disclosure of nature's secrets." Seventeenth-century scientists, reinforcing aggressive attitudes toward nature, spoke out in favor of "mastering" and "managing" the earth. Descartes wrote in his *Discourse on Method* (1636) that through knowing the crafts of the artisans and the forces of bodies we could "render ourselves the masters and possessors of nature."[14] Joseph Glanvill, the English philosopher who defended the Baconian program in his *Plus Ultra* of 1668, asserted that the objective of natural philosophy was to "enlarge knowledge by observation and experiment . . . so that nature being known, it may be mastered, managed, and used in the services of humane life." To achieve this objective, arts and instruments should be developed for "searching out the beginnings and depths of things and discovering the intrigues of remoter nature."[15] The most useful of the arts were chemistry, anatomy, and mathematics; the best instruments included the microscope, telescope, thermometer, barometer, and air pump.

The new image of nature as a female to be controlled and dissected through experiment legitimated the exploitation of natural resources. Although the image of the nurturing earth popular in the Renaissance did not vanish, it was superseded by new controlling imagery. The constraints against penetration associated with the earth-mother image were transformed into sanctions for denudation. After the Scientific Revolution, *Natura* no longer complains that her garments of modesty are being torn by the wrongful thrusts of man. She is portrayed in statues by the French sculptor Louis-Ernest Barrias (1841–1905) coyly removing her own veil and exposing herself to science. From an active teacher and parent, she has become a mindless, submissive body. Not only did this new image function as a sanction, but the new conceptual framework of the Scientific Revolution—mechanism—carried with it norms quite different from the norms of organicism. The new mechanical order and its associated values of power and control would mandate the death of nature.

## THE MECHANICAL ORDER

The fundamental social and intellectual problem for the seventeenth century was the problem of order. The perception of disorder, so important to the Baconian doctrine of dominion over nature, was also crucial to the rise of mechanism as a rational antidote to the disintegration of the organic cosmos. The new mechanical philosophy of the mid-seventeenth century achieved a reunification of the cosmos, society, and the self in terms of a new metaphor—the machine. Developed by the French thinkers Mersenne, Gassendi, and Descartes in the 1620s and 1630s and elaborated by a group of English emigrés to Paris in the 1640s and 1650s, the new mechanical theories emphasized and reinforced elements in human experience developing slowly since the late Middle Ages, but accelerating in the sixteenth century.

New forms of order and power provided a remedy for the disorder perceived to be spreading throughout culture. In the organic world, order meant the function of each part within the larger whole, as determined by its nature, while power was diffused from the top downward through the social or cosmic hierarchies. In the mechanical world, order was redefined to mean the predictable behavior of each part within a rationally determined system of laws, while power derived from active and immediate intervention in a secularized world. Order and power together constituted control. Rational control over nature, society, and the self was achieved by redefining reality itself through the new machine metaphor.

As the unifying model for science and society, the machine has permeated and reconstructed human consciousness so totally that today we scarcely question its validity. Nature, society, and the human body are composed of interchangeable atomized parts that can be repaired or replaced from outside. The "technological fix" mends an ecological malfunction, new human beings replace the old to maintain the smooth functioning of industry and bureaucracy, and interventionist medicine exchanges a fresh heart for worn-out, diseased one.

The mechanical view of nature now taught in most Western schools is accepted without question as our everyday, common sense reality—matter is made up of atoms, colors occur by the reflection of light waves of differing lengths, bodies obey the law of inertia, and the sun is in the center of our solar system. None of this was common sense to our seventeenth-century counterparts. The replacement of the older, "natural" ways of thinking by a new and "unnatural" form of life—seeing, thinking, and behaving—did not occur without struggle. The submergence of the organism by the machine engaged the best minds of the times during a period fraught with anxiety, confusion, and instability in both the intellectual and social spheres.

The removal of animistic, organic assumptions about the cosmos constituted the death of nature—the most far-reaching effect of the Scientific Revolution. Because nature was now viewed as a system of dead, inert particles moved by external, rather than inherent forces, the mechanical framework

itself could legitimate the manipulation of nature. Moreover, as a conceptual framework, the mechanical order had associated with it a framework of values based on power, fully compatible with the directions taken by commercial capitalism.

The mechanistic view of nature, developed by the seventeenth-century natural philosophers and based on a Western mathematical tradition going back to Plato, is still dominant in science today. This view assumes that nature can be divided into parts and that the parts can be rearranged to create other species of being. "Facts" or information bits can be extracted from the environmental context and rearranged according to a set of rules based on logical and mathematical operations. The results can then be tested and verified by resubmitting them to nature, the ultimate judge of their validity. Mathematical formalism provides the criterion for rationality and certainty, nature the criterion for empirical validity and acceptance or rejection of the theory.

The work of historians and philosophers of science notwithstanding, it is widely assumed by the scientific community that modern science is objective, value-free, and context-free knowledge of the external world. To the extent to which the sciences can be reduced to this mechanistic mathematical model, the more legitimate they become as sciences. Thus the reductionist hierarchy of the validity of the sciences first proposed in the nineteenth century by French positivist philosopher August Comte is still widely assumed by intellectuals, the most mathematical and highly theoretical sciences occupying the most revered position.

The mechanistic approach to nature is as fundamental to the twentieth-century revolution in physics as it was to classical Newtonian science, culminating in the nineteenth-century unification of mechanics, thermodynamics, and electromagnetic theory. Twentieth-century physics still views the world in terms of fundamental particles—electrons, protons, neutrons, mesons, muons, pions, taus, thetas, sigmas, pis, and so on. The search for the ultimate unifying particle, the quark, continues to engage the efforts of the best theoretical physicists.

Mathematical formalism isolates the elements of a given quantum mechanical problem, places them in a latticelike matrix, and rearranges them through a mathematical function called an *operator.* Systems theory extracts possibly relevant information bits from the environmental context and stores them in a computer memory for later use. But since it cannot store an infinite number of "facts," it must select a finite number of potentially relevant pieces of data according to a theory or set of rules governing the selection process. For any given solution, this mechanistic approach very likely excludes some potentially relevant factors.

Systems theorists claim for themselves a holistic outlook, because they believe that they are taking into account the ways in which all the parts in a given system affect the whole. Yet the formalism of the calculus of probabilities excludes the possibility of mathematizing the gestalt—that is, the ways in

which each part at any given instant take their meaning from the whole. The more open, adaptive, organic, and complex the system, the less successful is the formalism. It is most successful when applied to closed, artificial, precisely defined, relatively simple systems. Mechanistic assumptions about nature push us increasingly in the direction of artificial environments, mechanized control over more and more aspects of human life, and a loss of the quality of life itself.

## HOLISM

Holism was proposed as a philosophical alternative to mechanism by J. C. Smuts in his book *Holism and Evolution* (1926), in which he attempted to define the essential characteristics of holism and to differentiate it from nineteenth-century mechanism. He attempts to show that

> Taking a plant or animal as a type of whole, we notice the fundamental holistic characters as a unity of parts which is so close and intense as to be more than a sum of its parts; which not only gives a particular conformation or structure to the parts but so relates and determines them in their synthesis that their functions are altered; the synthesis affects and determines the parts so that they function toward the "whole"; and the whole and the parts therefore reciprocally influence and determine each other and appear more or less to merge their individual characters.[16]

Smuts saw a continuum of relationships among parts from simple physical mixtures and chemical compounds to organisms and minds in which the unity among parts was affected and changed by the synthesis. "Holism is a process of creative synthesis; the resulting wholes are not static, but dynamic, evolutionary, creative. . . . The explanation of nature can therefore not be purely mechanical; and the mechanistic concept of nature has its place and justification only in the wider setting of holism."

The most important example of holism today is provided by the science of ecology. Although ecology is a relatively new science, its philosophy of nature, holism, is not. Historically, holistic presuppositions about nature have been assumed by communities of people who have succeeded in living in equilibrium with their environments. The idea of cyclical processes, of the interconnectedness of all things, and the assumption that nature is active and alive are fundamental to the history of human thought. No element of an interlocking cycle can be removed without the collapse of the cycle. The parts themselves thus take their meaning from the whole. Each particular part is defined by and dependent on the total context. The cycle itself is a dynamic interactive relationship of all its parts, and process is a dialectical relation between parts and whole. Ecology necessarily must consider the complexities and the totality. It cannot isolate the parts into simplified systems that can be studied in a laboratory because such isolation distorts the whole.

External forces and stresses on a balanced ecosystem, whether natural or man made, can make some parts of the cycle act faster than the systems' own natural oscillations. Depending on the strength of the external disturbance, the metabolic and reproductive reaction rates of the slowest parts of the cycle, and the complexity of the system, it may or may not be able to absorb the stresses without collapsing.[17] At various times in history, civilizations which have put too much external stress on their environments have caused long-term or irrevocable alterations.

## CONCLUSION

By pointing up the essential role of every part of an ecosystem, that if one part is removed the system is weakened and loses stability, ecology has moved in the direction of the leveling of value hierarchies. Each part contributes equal value to the healthy functioning of the whole. All living things, as integral parts of a viable ecosystem, thus have rights. The necessity of protecting the ecosystem from collapse due to the extinction of vital members was one argument for the passage of the Endangered Species Act of 1973. The movement toward egalitarianism manifested in the democratic revolutions of the eighteenth century, the extension of citizens' rights to blacks, and finally, voting rights to women was thus carried a step further. Endangered species became equal to the Army Corps of Engineers: the snail darter had to have a legal hearing before the Tellico Dam could be approved, the Furbish lousewort could block construction of the Dickey-Lincoln Dam in Maine, the red-cockaded woodpecker must be considered in Texas timber management, and the El Segundo Blue Butterfly in California airport expansion.

The conjunction of conservation and ecology movements with women's rights and liberation has moved in the direction of reversing both the subjugation of nature and women. In the late nineteenth and early twentieth centuries, the strong feminist movement in the United States begun in 1842 pressed for women's suffrage first in the individual states and then in the nation. Women activists also formed conservation committees in the many women's organizations that were part of the Federation of Women's Clubs established in 1890. They supported the preservationist movement for national, state, and city parks and wilderness areas led by John Muir and Frederick Law Olmsted, eventually splitting away from the managerial, utilitarian wing headed by Gifford Pinchot and Theodore Roosevelt.[18]

Today the conjunction of the women's movement with the ecology movement again brings the issue of liberation into focus. Mainstream women's groups such as the League of Women Voters took an early lead in studying and pressing for clean air and water legislation. Socialist-feminist and "science for the people" groups worked toward revolutionizing economic structures in a direction that would equalize female and male work options and reform a capitalist system that creates profits at the expense of nature and working people.

The March 1979 accident at the Three-Mile Island nuclear reactor near Harrisburg, Pennsylvania, epitomized the problems of the "death of nature" that have become apparent since the Scientific Revolution. The manipulation of nuclear processes in an effort to control and harness nature through technology backfired into disaster. The long-range economic interests and public image of the power company and the reactor's designer were set above the immediate safety of the people and the health of the earth. The hidden effects of radioactive emissions, which by concentrating in the food chain could lead to an increase in cancers over the next several years, were initially downplayed by those charged with responsibility for regulating atomic power.

Three-Mile Island is a recent symbol of the earth's sickness caused by radioactive wastes, pesticides, plastics, photochemical smog, and fluorocarbons. The pollution "of her purest streams" has been supported since the Scientific Revolution by an ideology of "power over nature," an ontology of interchangeable atomic and human parts, and a methodology of "penetration" into her innermost secrets. The sick earth, "yea dead, yea putrified," can probably in the long run be restored to health only by a reversal of mainstream values and a revolution in economic priorities. In this sense, the world must once again be turned upside down.

As natural resources and energy supplies diminish in the future, it will become essential to examine alternatives of all kinds so that, by adopting new social styles, the quality of the environment can be sustained. Decentralization, nonhierarchical forms of organization, recycling of wastes, simpler living styles involving less-polluting "soft" technologies, and labor-intensive rather than capital-intensive economic methods are possibilities only beginning to be explored.[19] The future distribution of energy and resources among communities should be based on the integration of human and natural ecosystems. Such a restructuring of priorities may be crucial if people and nature are to survive.

## NOTES

1. On the tensions between technology and the pastoral ideal in American culture, see Leo Marx, *The Machine in the Garden* (New York: Oxford University Press, 1964). On the domination of nature as female, see Annette Kolodny, *The Lay of the Land* (Chapel Hill: University of North Carolina Press, 1975); Rosemary Radford Ruether, "Women, Ecology, and the Domination of Nature," *The Ecumenist* 14 (1975): 1–5; William Leiss, *The Domination of Nature* (New York: Braziller, 1972). On the roots of the ecological crisis, see Donald Hughes, *Ecology in Ancient Civilizations* (Albuquerque: University of New Mexico Press, 1976); Lynn White, Jr., *Medieval Technology and Social Change* (New York: Oxford University Press, 1966); and L. White, Jr., "Historical Roots of Our Ecological Crisis," in White, Jr. *Machina ex Deo* (Cambridge, Mass.: M.I.T. Press, 1968), pp. 75–94; Reijer Hooykaas, *Religion and the Rise of Modern Science* (Grand Rapids, Mich.: Eerdmans, 1972); Christopher Derrick, *The Delicate Creation: Towards a Theology of the Environment* (Old Greenwich, Conn.: Devin-Adair, 1972). On traditional rituals in the mining of ores and in metallurgy, see Mircea Eliade, *The Forge and the Crucible*, trans. Stephan Corrin (New York: Harper & Row, 1962), pp. 42, 53–70, 74, 79–96. On the divergence between attitudes and practices toward the environment, see Yi-Fu Tuan,

"Our Treatment of the Environment in Ideal and Actuality," *American Scientist* (May-June 1970): 246–49.

2. Treatments of Francis Bacon's contributions to science include Paolo Rossi, *Francis Bacon: From Magic To Science* (London: Routledge & Kegan Paul, 1968); Lisa Jardine, *Francis Bacon: Discovery and the Art of Discourse* (Cambridge, England: Cambridge University Press, 1974); Benjamin Farrington, *Francis Bacon, Philosopher of Industrial Science* (New York: Schumann, 1949); Margery Purver, *The Royal Society: Concept and Creation* (London: Routledge & Kegan Paul, 1967).
3. Bacon, "The Great Instauration" (written 1620), *Works*, vol. 4, p. 20; "The Masculine Birth of Time," ed. and trans. Benjamin Farrington, in *The Philosophy of Francis Bacon* (Liverpool, England: Liverpool University Press, 1964), p. 62; "De Dignitate," *Works*, vol. 4, pp. 287, 294.
4. Quoted in Moody E. Prior, "Bacon's Man of Science," in Leonard M. Marsak, ed., *The Rise of Modern Science in Relation to Society* (London: Collier-Macmillan, 1964), p. 45.
5. Rossi, p. 21; Leiss, p. 56; Bacon, *Works*, vol. 4, p. 294; Henry Cornelius Agrippa, *De Occulta Philosophia Libri Tres* (Antwerp, 1531): "No one has such powers but he who has cohabited with the elements, vanquished nature, mounted higher than the heavens, elevating himself above the angels to the archetype itself, with whom he then becomes cooperator and can do all things," as quoted in Frances A. Yates, *Giordano Bruno and the Hermetic Tradition* (New York: Vintage Books, 1964), p. 136.
6. Bacon, "Novum Organum," Part 2, in *Works*, vol. 4, p. 247; "Valerius Terminus," *Works*, vol. 3, pp. 217, 219; "The Masculine Birth of Time," trans. Farrington, p. 62.
7. Bacon, "The Masculine Birth of Time," and "The Refutation of Philosophies," trans. Farrington, pp. 62, 129, 130.
8. Bacon, "De Augmentis," *Works*, vol. 4, p. 294; see also Bacon, "Aphorisms," *Works*, vol. 4.
9. "De Augmentis," *Works*, vol. 4, pp. 320, 325; Plato, "The Timaeus," in *The Dialogues of Plato*, trans. B. Jowett (New York: Random House, 1937), vol. 2, p. 17; Bacon, "Parasceve," *Works*, vol. 4, p. 257.
10. Bacon, "De Augmentis," *Works*, vol. 4, pp. 343, 287, 343, 393.
11. Bacon, "Novum Organum," *Works*, vol. 4, p. 246; "The Great Instauration," *Works*, vol. 4, p. 29; "Novum Organum," Part 2, *Works*, vol. 4, p. 247.
12. Bacon, "Thoughts and Conclusions on the Interpretation of Nature or A Science of Productive Works," trans. Farrington, *The Philosophy of Francis Bacon*, pp. 96, 93, 99.
13. Bacon, "De Augmentis," *Works*, vol. 4, p. 294; "Parasceve," *Works*, vol. 4, p. 257; "Plan of the Work," vol. 4, p. 32; "Novum Organum," *Works*, vol. 4, pp. 114, 115.
14. René Descartes, "Discourse on Method," Part 4, in E. S. Haldane and G. R. T. Ross, eds., *Philosophical Works of Descartes* (New York: Dover, 1955), vol. 1, p. 119.
15. Joseph Glanvill, *Plus Ultra* (Gainesville, Fla.: Scholar's Facsimile Reprints, 1958; first published 1668), quotations on pp. 9, 87, 13, 56, 104, 10.
16. J. C. Smuts, *Holism and Evolution* (New York: Macmillan, 1926), pp. 86, 87. On holism in the biological sciences, see Arthur Koestler, "Beyond Holism and Reductionism: The Concept of the Holon," in *Beyond Reductionism: New Perspectives in the Life Sciences*, ed. A. Koestler and J. R. Smythies (Boston: Beacon Press, 1969).
17. On ecological cycles, see Barry Commoner, *The Closing Circle: Nature, Man, and Technology* (New York; Bantam Books, 1971), Chap. 2.
18. Samuel P. Hays, *Conservation and the Gospel of Efficiency: The Progressive Conservation Movement*, 1890–1920 (Cambridge, Mass.: Harvard University Press, 1959), pp. 142–43.
19. Murray Bookchin, "Ecology and Revolutionary Thought," in *Post-Scarcity Anarchism* (San Francisco: Ramparts Press, 1971), pp. 57–82, and M. Bookchin, "Toward an Ecological Solution" (Berkeley, Calif.: Ecology Center Reprint, n.d.). See also Victor Ferkiss, *Technological Man* (New York: New American Library, 1969), Chap. 9, pp. 205–11; Theodore Roszak, *Where the Wasteland Ends* (Garden City, N.Y.: Doubleday, 1973), pp. 367–71; Paul Goodman and Percival Goodman, *Communitas*, 2nd ed., rev. (New York: Vintage, 1960); Paul Goodman, *People or Personnel* (New York: Random House, 1965); E. F. Schumacher, *Small Is Beautiful: Economics as if People Mattered* (New York: Harper & Row, 1973); Ernest Callenbach, *Ecotopia* (Berkeley, Calif.: Banyan Tree Books, 1976).