

The Theoretical Structure of Ecological Revolutions

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Environmental history has reached a point in its evolution in which explicit attention to the theories that underlie its various interpretations is called for. The papers in this special issue on "Theories of Environmental History" begin a dialogue about the merits and limitations of differing approaches. Theories about the social construction of science and nature that have emerged over the past decade in the wake of Thomas Kuhn's *Structure of Scientific Revolutions* is one such approach. It accepts the relativist stance toward science set forth in the first edition of his book. (Kuhn backed away from that position toward a view of the progress of knowledge in a second edition.) Marxist theories that attempt to understand history as constructions of the material-social world existing in particular times and places provide a second influence. The theory of ecological revolutions that follows draws on social construction approaches and uses New England as a case study.¹

Two major transformations in New England land and life took place between 1600 and 1860. The first, a colonial ecological revolution, occurred during the seventeenth century and was externally generated. It resulted in the collapse of indigenous Indian ecologies and the incorporation of a European ecological complex of animals, plants, pathogens, and people. It was legitimated by a set of symbols that placed cultured Europeans above wild nature, other animals, and "beastlike savages." It substituted a visual for an oral consciousness and an image of nature as female and subservient to a transcendent male God for an animistic fabric of symbolic exchanges between people and nature.

The second transformation, a capitalist ecological revolution, took place roughly between the American Revolution and about 1860. That second revolution was internally generated and resulted in the reintroduction of soil nutrients and native species. It demanded an economy of increased human labor, land management, and a legitimating mechanistic science. It split human consciousness into a disembodied analytic mind and a romantic emotional sensibility.

My thesis is that ecological revolutions are major transformations in human relations with non-human nature. They arise from changes, tensions, and contradictions that develop between a society's mode of production and its ecology, and between its modes of production and reproduction. Those dynamics in turn support the acceptance of new

forms of consciousness, ideas, images, and world views. The course of the colonial and capitalist ecological revolutions in New England may be understood through a description of each society's production, reproduction, and forms of consciousness, the processes by which they broke down, and an analysis of the new relations between the emergent colonial or capitalist society and non-human nature.

Two frameworks of analysis offer springboards for discussing the structure of such ecological revolutions. In *The Structure of Scientific Revolutions* (first edition), Thomas Kuhn approached major transformations in scientific consciousness from a perspective internal to the workings of science and the community of scientists.

One of the strengths of Kuhn's provocative account is its recognition of stable world views in science that exist for relatively long periods but are rapidly transformed during times of crisis and stress. One of its limitations is its failure to incorporate an interpretation of social forces external to the daily activities of science practitioners in their laboratories and field stations. Social and economic circumstances affect internal developments in scientific theories, at least indirectly. A viewpoint that incorporates social, economic, and ecological changes is required for a more complete understanding of scientific change.

A second approach to revolutionary transformations is that of Karl Marx and Friedrich Engels. According to their base/superstructure theory of history, social revolutions begin in the economic base of a particular social formation and result in a fairly rapid transformation of the legal, political, and ideological superstructure. In the most succinct statement of his theory of history, Marx wrote:

At a certain stage of their development, the material productive forces of society come in conflict with the existing relations of production. . . . Then begins an epoch of social revolution. With the change of the economic foundation the entire immense superstructure is more or less rapidly transformed.²

One weakness of that approach is the determinism Marx assigns to the economic base and the sharp demarcation between base and superstructure. But its strength lies in its view of society and change. If a society at a given time can be understood as a mutually supportive structure of dynamically interacting parts, then the process of its breakdown and transformation to a new whole can be described. Both Kuhn's theory of scientific revolution and Marx's theory of social revolution are starting points for a theory of ecology and history.

Science and history are both social constructions. Science is an ongoing negotiation with non-human nature for what counts as reality. Scientists socially construct nature, representing it differently in different historical epochs. Those social constructions change during scientific revolutions. Historians also socially construct the past in accordance with concepts relevant to the historian's present. History is thus a continuing negotiation between the historian and historical sources. Ecology is

a particular twentieth-century construction of nature relevant to the concerns of environmental historians.

A scientific world view answers three key questions:

- (1) What is the world made of? (the ontological question)
- (2) How does change occur? (the historical question)
- (3) How do we know? (the epistemological question)

World views such as animism, Aristotelianism, mechanism, and quantum field theory construct answers to these fundamental questions differently.

Environmental history poses similar questions:

- (1) What concepts describe the world?
- (2) What is the process by which change occurs?
- (3) How does a society know the natural world?

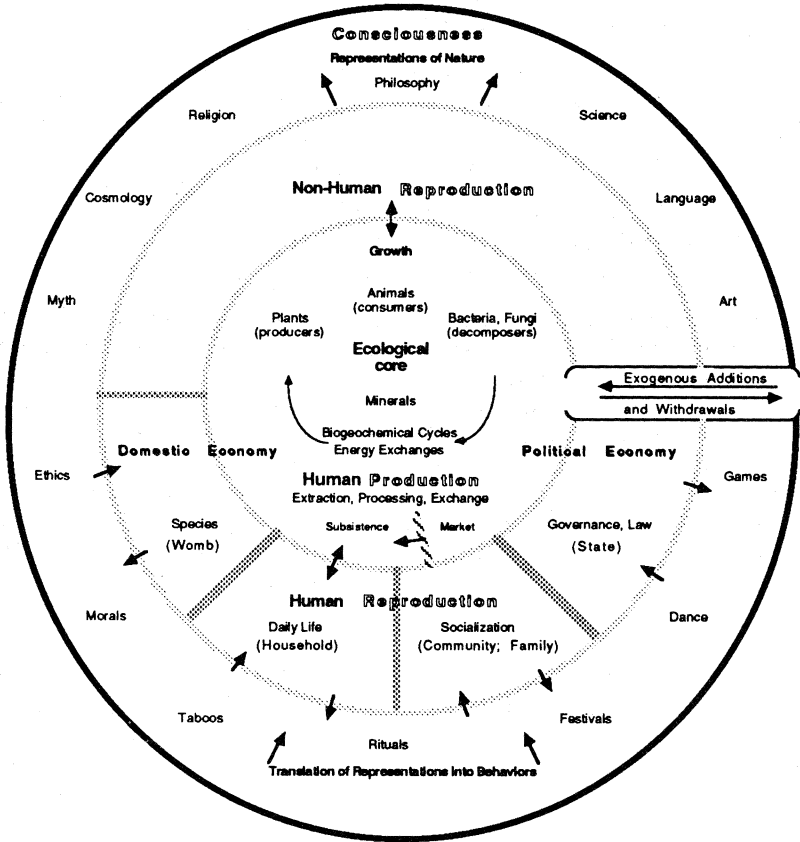
The concepts most useful for this approach to environmental history are ecology, production, reproduction, and consciousness. Because of the differences in the immediacy of impact of production, reproduction, and consciousness on non-human nature, a structured, leveled framework of analysis is needed. This framework provides the basis for an understanding of stability as well as evolutionary change and transformation. Although change may occur at any level, ecological revolutions are characterized by major alterations at all three levels. Widening tensions between the requirements of ecology and production in a given habitat and between production and reproduction initiate those changes. Those dynamics in turn lead to transformations in consciousness and legitimating world views. (See Figure 1.)

Since the Scientific Revolution of the seventeenth century, the West has seen nature primarily through the spectacles of mechanistic science. Matter is dead and inert, remaining at rest or moving with uniform velocity in a straight line unless acted on by external forces. Change comes from outside as in the operation of a machine. The world is a clock, adjustable by human clock makers; nature is passive and manipulable.

An ecological approach to history asserts the idea of nature as a historical actor. It challenges the mechanistic tradition by focusing on the interchange of energy, materials, and information among living and non-living beings in the natural environment. Non-human nature is not passive, but an active complex that participates in change over time and responds to human-induced change. Nature is a whole of which humans are only one part. We interact with plants, animals, and soils in ways that sustain or deplete local habitats, but through science and technology, we have greater power to alter the whole in a short period of time.

But like the mechanistic paradigm, the ecological paradigm is a socially constructed theory. Although it differs from mechanism by taking relations, context, and networks into consideration, it has no

Figure 1
Conceptual Framework for Interpreting
Ecological Revolutions



greater or lesser claim to ultimate truth than do earlier paradigms. Both mechanism and ecology construct their theories through a socially sanctioned process of problem identification, selection and deselection of particular "facts," inscription of the selected facts into texts, and the acceptance of a constructed order of nature by the scientific community. But laboratory and field ecology merge through the replication of laboratory conditions in the field. Farm, field, and forest are viewed as an ecological whole that includes both non-human nature and the human designer. The ecological approach of the twentieth century, like the earlier mechanistic one, has resulted from a socially constructed set of experiences sanctioned by scientific authority and a set of social practices and policies.³

Production is the human counterpart of "nature's" activity. The need to produce subsistence to reproduce human energy on a daily basis connects human communities with their local environments. Production for subsistence (or use) from the elements (or resources) of nature and the production of surpluses for market exchange are the primary ways in which humans interact directly with the local habitat. An ecological perspective unites the laws of nature with the processes of production through exchanges of energy. All animals, plants, and minerals are energy niches involved in the actual exchange of energy, materials, and information. The relation between human beings and the non-human world is reciprocal; when humans alter their surroundings, "nature" responds to those changes through ecological laws.

Production is the extraction, processing, and exchange of nature's parts as resources. In traditional cultures exchanges are often gifts or symbolic alliances while in market societies they are exchanged as commodities. For much of Western history, humans have produced and bartered food, clothing, and shelter primarily within the local community to reproduce daily life. But when commodities are marketed for profit, as in capitalist societies, they are often removed from the local habitat to distant places and exchanged for money. Marx and Engels distinguished between use-value production, or production for subsistence, and production for profit. When people "exploit" non-human nature, they do so in one of two ways: they either make immediate or personal use of it for subsistence, or they exchange its products as commodities for personal profit or gain.

New England is a significant historical example because several types of production evolved within the bounds of its present geographical area. Native Americans engaged primarily in gathering and hunting in the north and in horticulture in the south. Colonial Americans combined mercantile trade in natural resources with subsistence-oriented agriculture. The market and transportation revolutions of the nineteenth century initiated the transition to capitalist production. Historical bifurcation points within the evolutionary process can be identified *roughly* between 1600 and 1675 (the colonial ecological revolution) and between 1775 and 1860 (the capitalist ecological revolution).

To continue over time, life must be reproduced from generation to generation. The habitat is populated and repopulated with living organisms of all kinds. Biologically, all species must reproduce themselves inter-generationally. For humans, reproduction is both biological and social. Each adult generation must maintain itself, its parents, and its offspring so that human life may continue. And each individual must reproduce its own energy and that of its offspring (intra-generationally) on a daily basis through gathering, growing, or preparing food. Socially, humans must reproduce future laborers by passing on family and community norms. And they must reproduce and maintain the larger social order through the structures of governance and laws (such as property inheritance) and the ethical codes that reinforce behavior. Thus, although production is twofold—oriented toward subsistence use or market exchange—reproduction is fourfold, having both biological and social articulations.

Reproduction is the biological and social process through which humans are born, nurtured, socialized, and governed. Through reproduction sexual relations are legitimated, population sizes and family relationships are maintained, and property and inheritance practices are reinforced. In subsistence-oriented economies, production and reproduction are united in the maintenance of the local community. Under capitalism production and reproduction separate into two different spheres.

Claude Meillassoux's *Maidens, Meal, and Money* (1981) best explains the necessary connections between biological and social reproduction in subsistence economies. Production, he argues, exists for the sake of reproduction; the production and exchange of human energy are the keys to the reproduction of human life. Food must be extracted or produced to maintain the daily energy of producing adults, to maintain the energy of the children who will be the future producers, and to maintain that of the elders, the past producers. In this way reproducing life on a daily (intragenerational) basis through energy is linked directly to the intergenerational reproduction of the human species.⁴

Although the biological reproduction of life is possible only through the necessary connections between inter- and intragenerational reproduction, the community as a self-perpetuating unit is maintained by social reproduction. In addition, the political, legal, or governmental structures that maintain the mode of production will play the role of reproducing the social whole.⁵

Whereas Meillassoux was interested primarily in the concept of reproduction in subsistence societies, sociologist Abby Peterson examined the gender-sex dimension in politics to formulate an analysis of reproduction in capitalist societies. Under capitalism, the division of labor between the sexes has meant that men bear the responsibility for and dominate the production of exchange commodities, while women bear responsibility for reproducing the work force and social relations. Peterson argues:

Women's responsibility for reproduction includes both the biological reproduction of the species (intergenerational reproduction) and the intragenerational reproduction of the work force through unpaid labor in the home. Here too is included the reproduction of social relations—socialization.⁶

Under capitalist patriarchy, reproduction is subordinate to production.

Meillassoux's and Peterson's work offers an approach by which the analysis of reproduction can be advanced beyond demography to include daily life and the community itself. The sphere of reproduction is fourfold, having two biological and two social manifestations: (1) the intergenerational reproduction of the species (both human and non-human), (2) the intragenerational reproduction of daily life, (3) the reproduction of social norms within the family and community, and (4) the reproduction of the legal-political structures that maintain social order within the community and the state. The fourfold sphere of reproduction exists in a dynamic relationship with the twofold (subsistence or market-oriented) sphere of production.

Production and reproduction are in dynamic tension. When reproductive patterns are altered, as in population growth or changes in property inheritance, production is affected. Conversely, when production changes, as in the addition or depletion of resources or in technological innovation, reproductive structures are altered. A dramatic change at the level of either reproduction or production can alter the dynamic between them, resulting in a major transformation of the social whole.

Socialist-feminists have further elaborated the interaction between production and reproduction. In a 1976 article, "The Dialectics of Production and Reproduction in History," Renatè Bridenthal argues that changes in production give rise to changes in reproduction, creating tensions between them. For example, the change from an agrarian to an industrial capitalist economy—one that characterized the capitalist ecological revolution—can be described in terms of tensions, contradictions, and synthesis within the gender roles associated with production and reproduction. In the agrarian economy of colonial America, production and reproduction were symbiotic. Women participated in both spheres because the production and reproduction of daily life were centered in the household and domestic communities. Likewise, men working in barns and fields and women working in farmyards and farmhouses socialized children into production. But with industrialization, the production of items such as textiles and shoes moved out of the home into the factory, while farms became specialized and mechanized. Production became more public, reproduction more private, leading to their social and structural separation. For working-class women, the split between production and reproduction imposed a double burden of wage labor and housework; for middle-class women, it led to enforced idleness as "ladies of leisure."⁷

In New England the additional tensions between the requirements of intergenerational reproduction and those of subsistence production in

rural areas also stimulated the capitalist ecological revolution. A partible system of patriarchal inheritance meant that farm sizes decreased after three or four generations to the point that not all sons inherited enough land to reproduce the subsistence system. The tensions between the requirements of subsistence-oriented production (a large family labor force) and social reproduction through partible inheritance (all sons must inherit farms) helped create a supply of landless sons, wage laborers for the transition to capitalist agriculture. The requirements of reproduction in its fourfold sense, therefore, came into conflict with the requirements of subsistence-oriented (use-value) production, stimulating a movement toward capital-intensive market production.

Consciousness is the totality of one's thoughts, feelings, and impressions, the awareness of one's acts and volitions. Group consciousness is a collective awareness by an aggregate of individuals. Both environments and culture shape individual and group consciousness. In different historical epochs, particular characteristics dominate a society's consciousness. Those forms of consciousness, through which the world is perceived, understood, and interpreted, are socially constructed and subject to change.

A society's symbols and images of nature express its collective consciousness. They appear in mythology, cosmology, science, religion, philosophy, language, and art. Scientific, philosophical, and literary texts are sources of the ideas and images used by controlling elites, whereas rituals, festivals, songs, and myths provide clues to the consciousness of ordinary people. Ideas, images, and metaphors legitimate human behavior toward nature and are translated into action through ethics, morals, and taboos. According to Charles Taylor, particular intellectual frameworks give rise to a certain range of normative variations and not others, because their related values are not accidental. When sufficiently powerful, world views and their associated values can override social changes. But if they are weak, they can be undermined. A tribe of New England Indians or a community of colonial Americans may have a religious world view that holds it together for many decades while its economy is gradually changing. But eventually with the acceleration of commercial change, ideas that had formerly existed on the periphery, or among selected elites, may become dominant if they support and legitimate the new economic directions.⁸

For Native American cultures, consciousness was an integration of all the bodily senses in sustaining life. In that mimetic consciousness, culture was transmitted intergenerationally through imitation in song, myth, dance, sport, gathering, hunting, and planting. Aural/oral transmission of tribal knowledge through myth and transactions between animals, Indians, and neighboring tribes produced sustainable relations between the human and the non-human worlds. The primal gaze of locking eyes between hunter and hunted initiated the moment of ordained killing when the animal gave itself up so that the Indian could

survive. (The very meaning of the gaze stems from the intent look of expectancy when a deer first sees a fire, becomes aware of a scent, or looks into the eyes of a pursuing hunter.) For Indians engaged in an intimate survival relationship with nature, sight, smell, sound, taste, and touch were all of equal importance, integrated in a total participatory consciousness.⁹

When Europeans took over Native American habitats during the colonial ecological revolution, vision became dominant within the mimetic fabric. Although imitative, oral, face-to-face transactions still guided daily life for most colonial settlers and Indians, Puritan eyes turned upward toward a transcendent God who sent down his word in written form in the Bible. Individual Protestants learned to read so that they could interpret God's word for themselves. The biblical word in turn legitimated the imposition of agriculture and artifact in the new land. The objectifying scrutiny of fur trader, lumber merchant, and banker who viewed nature as resource and commodity submerged the primal gaze of the Indians. Treaties and property relations that extracted land from the Indians were codified in writing. Alphanumeric literacy became central to religious expression, social survival, and upward mobility.¹⁰

The Puritan imposition of a visually oriented consciousness was shattering to the continuation of Indian animism and ways of life. With the commercializing of the fur trade and the missionary efforts of Jesuits and Puritans, a society in which humans, animals, plants, and rocks were equal subjects was changed to one dominated by transcendent vision in which human subjects were separate from resource objects. That change in consciousness characterized the colonial ecological revolution.

The rise of an analytical, quantitative consciousness was a feature of the capitalist ecological revolution. Capitalist ecological relations emphasized efficient management and control of nature. With the development of mechanistic science and its use of perspective diagrams, visualization was integrated with numbering. The superposition of scientific, quantitative approaches to nature and its resources characterized the capitalist ecological revolution. Through education, analytic consciousness expanded beyond that of dominant elites to include most ordinary New Englanders.

Viewed as a social construction, "nature" (as it was conceptualized in each social epoch—Indian, colonial, and capitalist) is not some ultimate truth that was gradually discovered through the scientific processes of observation, experimentation, and mathematics. Rather, it was a relative, changing structure of human representations of "reality." Ecological revolutions are processes through which different societies change their relationship to nature. They arise from tensions between production and ecology, and between production and reproduction. The results are new constructions of nature, both materially and in human consciousness.

Notes

¹Thomas S. Kuhn, *The Structure of Scientific Revolutions* 2d ed. (Chicago, 1970). The theory and illustrations presented here are drawn from my forthcoming book, *Ecological Revolutions: Nature, Gender, and Science in New England*.

²Karl Marx, "Preface to *A Contribution to the Critique of Political Economy*," (1859) in Karl Marx and Friedrich Engels, *Selected Works* (New York, 1968), 182-83.

³Elizabeth Ann R. Bird, "The Social Construction of Nature: Theoretical Approaches to the History of Environmental Problems," *Environmental Review* 11 (Winter 1987); Karin D. Knorr-Cetina and Michael Mulkay, eds., *Science Observed, Perspectives on the Social Study of Science* (Beverly Hills, 1983); and Karin D. Knorr-Cetina, *The Manufacture of Knowledge: An Essay on the Constructivist and Contextual Nature of Science* (New York, 1981).

⁴Claude Meillassoux, *Maidens, Meal, and Money: Capitalism and the Domestic Community* (1975; English trans., Cambridge, 1981). Critiques of Meillassoux include Bridget O'Laughlin, "Production and Reproduction: Meillassoux's *Femmes, Greniers et Capitaux*," *Critique of Anthropology* 2 (Spring 1977), 3-33; and Maureen Mackintosh, "Reproduction and Patriarchy: A Critique of Claude Meillassoux, *Femmes, Greniers et Capitaux*," *Capital and Class* 2 (Summer 1977), 114-27.

⁵Meillassoux, *Maidens, Meal, and Money*, 36, 39.

⁶Abby Peterson, "The Gender-Sex Dimension in Swedish Politics," *Acta Sociologica* 27, no. 1 (1984), 6, 3-17. Peterson's fourfold taxonomy of political interests included (1) Issues related to the interests of intergenerational reproduction; (2) Issues related to the interests of intragenerational reproduction in the family; (3) Issues related to the interests of intragenerational reproduction in the public sector; and (4) Issues related to the interests of reproduction workers (women), i.e. so-called women's liberation issues. Peterson also applied her taxonomy to the politics of reproduction in the Swedish environmental movement. See Abby Peterson and Carolyn Merchant, "'Peace With the Earth': Women and the Environmental Movement in Sweden," *Women's Studies International Forum* 9 (1986), 465-79, esp. 472-74.

⁷Rena t Bridenthal, "The Dialectics of Production and Reproduction in History," *Radical America* 10 (March-April 1976), 3-11. For a feminist analysis of reproduction in American culture, see Women's Work Study Group, "Loom, Broom, and Womb: Producers, Maintainers, and Reproducers," *Radical America* 10 (March-April 1976), 29-45; and Veronica Beechley, "On Patriarchy," *Feminist Review* 10 (March-June 1980), 169-88.

⁸Charles Taylor, "Neutrality in Political Science," in Alan Ryan, ed., *The Philosophy of Social Explanation* (London, 1973), 139-70, see pp. 144-46, 154-55.

⁹On mimetic, participatory consciousness, see Morris Berman, *The Reenchantment of the World* (Ithaca, 1981); Eric Havelock, *Preface to Plato* (Cambridge, MA, 1963); and Max Horkheimer, *The Eclipse of Reason* (New York, n.d.), 92-127. On the gaze, see *Compact Oxford English Dictionary*, s.v. "gaze": "said of a deer, also of persons, especially in wonder, expectancy, bewilderment." "The hart, stag, buck, or hind when borne in coat-armour, looking affront e or full faced is said to be at gaze . . . but all other beasts in this attitude are called guardant." William Berry, *Encyclopedia Heraldica*, s.v. "gaze." On the Koyukon Indian versus white methods of hunting the deer, see Richard K. Nelson, "The Gifts," in Daniel Halpern, ed., *Antaeus* no. 57 (Autumn, 1986), 117-31, esp. 122. On imitation of animals by humans in hunting, see Randall L. Eaton, "Hunting and the Great Mystery of Nature," *Utne Reader* (January/February 1987), 42-49.

¹⁰On the dominance of vision in Western consciousness see Hans Jonas, "The Nobility of Sight," *Philosophy and Phenomenological Research* 14 (1954), 507-19; Evelyn Fox Keller and Christine Grontkowski, "The Mind's Eye," in Sandra Harding and Merrill B. Hintikka, eds., *Discovering Reality* (Dordrecht, Holland, 1983), 207-24; James Axtell, "The Power of Print in the Eastern Woodlands," *William and Mary Quarterly* 44 (2) 3rd ser. (April 1987), 300-9.