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The Sociology of Ecology

Ecological Organicism Versus Ecosystem Ecology in the Social Construction of Ecological Science, 1926-1935

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Environmental sociology has been divided in recent years by a debate between realists and constructionists centering on the knowledge claims of ecological science. Following a consideration of this debate and its relation to both environmental sociology and the "sociology of ecology," a "realist constructionism" is advanced, taking as its concrete case the conflict in the 1920s and 1930s between Jan Christian Smuts's organicist ecology and Arthur Tansley's ecosystem ecology. A central analytical issue (derived from Marx and Engels) is the "double transfer" of ideas from society to nature and back again and how this was manifested in the early 20th-century ecology in the form of a justification for ecological racism/apartheid.

Keywords: *ecology; ecosystem; Smuts; Tansley; Marx; materialism; dialectics; double transfer; realist constructionism; ecological racism; critical realism; standpoint theory; environmental sociology; sociology of science; environmentalism*

The Sociology of Ecology: Transcending the Realist-Constructionist Divide

A key dividing line within environmental sociology—even more perhaps than in sociology in general—is the question of "realism" versus "constructionism." To what extent is nature independent of human action and even conceptions, and to what extent is it constructed by society and human thought processes? Realists within environmental sociology tend to materialism and think in terms of nature's ontological independence of human action and conceptions. They emphasize natural limits to human action. In this view, nature can be successfully altered to meet human needs up to a point—but only if nature's laws and limits are first recognized and followed. This view is compatible with a dynamic notion of nature that incorporates evolutionary postulates. Constructionists, in contrast, tend to idealism and skepticism, and they stress the epistemological limits of our knowledge of nature. They underscore the extent to which nature as we know it is constructed by human

actions and cognition, and they are suspicious of what they regard as "essentialist" or "positivistic" postulates about nature. In this view, social development is frequently conceived (if only for methodological purposes) as unconstrained by natural forces, which can therefore be set aside in purely social analysis.

A common complaint of realist environmental sociologists is that sociology in the 20th century has leaned toward a broad, overarching constructionism and human exemptionalism (the notion that human beings are mostly exempt from nature's laws), ignoring or downplaying realist concerns with natural limits, and cordoning social science off from natural science. This has only been heightened by the so-called "cultural turn" in sociology. Constructionist environmental sociologists, for their part, complain of the naïve view of science as a mirror of nature and the technological Prometheanism that they attribute to realism (here reduced to crude positivism).

There are of course sophisticated versions of each of these views. Critical realists recognize the epistemological obstacles to our knowing the Kantian "thing in itself" (or "intransitive objects of scientific knowledge" [Bhaskar, 1979]) and stress the historical basis of human actions and cognition. Cautious constructionists explicitly acknowledge that there are natural limits (the existence of "a reality out there") within which human beings are constrained and that our cognition is a coproduct of nature and society. Some advocates of the "strong programme" in the sociology of science—a view generally seen as adamantly constructionist—argue that a kind of idealism at the level of categories and truth claims "is compatible with an underlying materialism" (Bloor, 1991, p. 175).

Nevertheless, the division between realism and constructionism continues to bedevil environmental sociology in particular (a field that necessarily transgresses the divide between society and nature at every point), creating quite distinct theoretical emphases. Realists within environmental sociology are concerned primarily with the ontology of environmental crisis and see this as a reason to alter existing social relations. Constructionists focus much more on the epistemological aspects and "reflexivity" of our construction of nature and science, seeing environmental crises first and foremost as discursive constructions and therefore open to diverse interpretations.[1]

In what follows, we attempt to throw further light on the realist–constructionist divide and to show how this division can be transcended through a realist–constructionist account rooted in a particular, situated context—the historic formation of ecological science in the early 20th century. We ask questions such as the following: (a) To what extent was the growth of ecology as a science an attempt not simply to construct a new scientific understanding of nature, but a manifestation of developing social relations of production and emerging conflicts within human society that were transferred to the realm of nature/ecology (and then frequently reimported into society as naturalized facts)? (b) How are current conceptions of ecological crisis within ecological science affected by the human–historical conflicts that entered at the outset into the very constitution of ecological science? (c)What form of the sociology of ecological science is the best counterpart to an environmental sociology concerned centrally with ecological crisis?

What we hope to demonstrate is the importance of both ontological realism and historical constructionism, synthesized within a critical–realist perspective. We argue that within both natural science and social science (and especially within ecology, which increasingly embraces both), it is essential to retain a realist/materialist view that also embraces an

understanding of the human–historical construction of the world within limits. Ultimately, there is no contradiction between the Galileo principle ("it still moves") and the Vico principle ("we can understand it because we made it") if each of these is properly understood and delimited. In a slight revision of Marx's principle of historical materialism, we can say human beings make their own history, not under conditions of their choosing but rather on the basis of natural–environmental and social conditions inherited from the past.[2]

For environmental sociologists to raise such matters in the context of the development of ecological science is of course to trespass on the realm of the sociology of science, which specializes in precisely these kinds of difficult inquiries into science—but in ways that are only rarely directly pertinent to environmental sociology and that seldom address the materialist/realist tradition. In the following analysis, we will make use of insights drawn especially from the early "externalist" (or social–institutional) approach to the sociology of science associated with such thinkers as Hessen, Zilsel, and Merton. In addition, we make use of Marxist and feminist "standpoint theory" and draw on Lakatos's (1978) distinction between "progressive" and "degenerative" research programs. Our overall analysis here is influenced by Bhaskar's (1979, 1986) and Sayer's (1992) critical realism.

Following this excursion into the sociology and philosophy of science, we use some of the analytical tools derived there to elucidate the concrete core of our argument, focusing on the struggle over the foundations of ecology as an emerging scientific field of research from 1926 to 1935. This saw the development of two competing ecological holisms. One of these approaches arose out of a tradition of idealism and organicism and is represented most fully by the ecological holism/racism of Jan Christian Smuts and his followers within ecological science in South Africa. The other flowed out of a tradition of materialism and took its most definitive form in the ecosystem ecology of Arthur Tansley in Britain.

Not only did these two traditions openly war with each other, but they also crossed swords in surprising ways that demonstrate that the development of science can never be cordoned off from the larger social struggles or our conceptions of nature from those of society. The importance of realist–constructionist accounts of science (particularly if conceived in historical and materialist ways) is highlighted. For example, only in this way is one able to deal with the issue, raised by Marx and Engels, of the "double transference" of ideas of nature and society and the erroneous naturalization of social relations that has sometimes resulted.

Our argument calls into question the traditional social science/humanities story, as often depicted by environmental historians and environmental sociologists, that—in opposition to the main line of ecological science—sides with Smuts's idealist, organicist "holism" against the materialist ecosystem ecology of Tansley. As David Pepper (1996) says, "the ecocentric interpretation of twentieth-century science tends towards . . . idealism" (p. 242). Indeed, we are frequently led to believe that ecology in following Tansley rather than Smuts simply took the wrong path, choosing reductionism over holism (see Barbour, 1995; Merchant, 1980, p. 252; Merchant, 1992, p. 59; Pepper, 1996, pp. 233-234, 242-245; Worster, 1977, pp. 301-304, 316-323).

Dissenting from this view, we attempt to illuminate why Tansley's ecosystem ecology reflected a "progressive" research program and Smuts's "holism" a "degenerating" research program (following Lakatos's distinction) in terms of the natural–scientific and also the social–scientific implications of these arguments. The materialist/realist view, we argue, was superior in both its ontological realism and its constructionist tendencies. It was more

attuned to the difficulties of the uncritical transference of social ideas to the natural realm and then their transference back (in objectivist, naturalist clothing) to the social—the problem of the double transference. Moreover, the situated social context in which these theories were developed ultimately, we believe, favored the evolution of ecological materialism. This suggests that not all ontologies and not all constructionisms are created equal. Our examination of the Smuts–Tansley debate, however, is more than an attempt simply to validate one view over another. Rather, it seeks to illustrate, through a situated case, that the real concern of a sociology of modern ecology should *not* be the strict opposition of realism versus constructionism but rather the coevolution of nature and society and its consequences.

Navigating the Great Divide: Realism Versus Constructionism

From its first appearance in the mid-1970s until the 1990s, environmental sociology was characterized by "an almost universal commitment . . . to a realist epistemology and a materialist ontology" (Buttel, Dickens, Dunlap, & Gijswijt, 2002, p. 22).[3] Nevertheless, the social constructionist perspective, which soon gained prominence within the sociology of science, social problems, and the sociology of gender, began strongly to impress itself on environmental sociology by the 1990s. The result was a debate between realists and constructionists that, while resembling similar controversies in other areas of sociology, took on an extremely virulent form.

From the beginning, environmental sociologists have charged that sociology as a discipline has been far more reluctant than other social science disciplines to incorporate natural–environmental postulates into its analysis—a failing, they claimed, that was less evident in the work of sociology's classical founders (Benton, 1994; Buttel, 1986, 1996; Dunlap & Catton, 1979; Foster, 1999; Goldman & Schurman, 2000; Murphy, 1994, 1997). In their original formulation that helped to launch the field, Catton and Dunlap (1978; Dunlap & Catton, 1994) presented environmental sociology as a subdiscipline, embodying a "new environmental paradigm" that opposed the "human exemptionalist" (from nature) assumptions prevalent in much of social science and sociology in particular.

Environmental sociology arose in conjunction with the environmental movement in the 1970s, spurred on like the latter by the warnings of scientists (e.g., Carson, 1962; Commoner, 1971) with regard to ecological crisis. Environmental sociologists thus saw themselves as addressing this developing ecological crisis from the standpoint of social systems, institutions, processes, and agents. Because of this focus on the reality of ecological crisis that had defined the field from the start, numerous environmental sociologists saw the sudden intrusion of strong social constructionist views into environmental sociology roughly a decade and a half after its inception as a threat to the very constitution of the subdiscipline. Realist environmental sociologists (Benton, 1994, pp. 44-46; Dickens, 1996; Martel, 1994; O'Neill, 1993, pp. 148-155) responded sharply to the antirealism, for example, of Tester (1991), who provocatively declared that

> a fish is only a fish if it is socially classified as one, and that classification is only concerned with fish to the extent that scaly things living in the sea help society define itself. . . . Animals are indeed a blank paper which can be inscribed with any message, and symbolic meaning, that the social wishes. (p. 46)

For realists within environmental sociology, this kind of strong social–constructionist "anti-realism," as it was sometimes called even by those sympathetic to it (see Hacking, 1988), only seemed to reinforce, at an even more extreme level, an anthropocentrism with regard to nature that environmental sociology from the beginning had sought to combat.

Realist environmental sociologists were further alarmed by the persistent questioning of not only science in general but also scientific depictions of ecological crises, as the methods and conclusions of sociologists of science influenced by the Edinburgh "strong programme" and the work of Latour and Woolgar (1979) began to filter into environmental sociology (e.g., Buttel & Taylor, 1992; Demeritt, 1998; Hannigan, 1995; Taylor & Buttel, 1992; Yearly, 1991). Thus, in extending arguments from the sociology of science into the terrain of environmental sociology, Yearly (1991) stressed the "*uncertain* basis" of the global warming hypothesis, which rested on questionable scientific authority and scientific framing, concluding that the fact that "we cannot know such things for certain" was the "Achilles heel" of environmental science, as with science in general (pp. 136-137). Realist environmental sociologists responded by insisting that in the face of the overwhelming scientific evidence and scientific consensus, with respect to global environmental crisis, to support skepticism in this area was to undermine the moral responsibility of society to nature and to future generations (Dunlap & Catton, 1994, pp. 22-23; Redclift & Woodgate, 1997, pp. 59-61).

Strong social constructionism is concerned with challenging the materialist/realist emphasis of science and gives credence in varying degrees to epistemologically based skepticism, nominalism, solipsism, antirealism, subjectivism, cultural relativism, and idealism in accounts of science and nature. In this, the strongest criticisms have been epistemological in character. Like philosophers who have traditionally seen epistemology as "polishing the mirror" of knowledge (Rorty, 1979), social constructionists in the sociology of science frequently see themselves as polishing the mirror of scientific knowledge. Science—contrary to widespread belief, even within science itself—is, we are told, more a mirror of the mind and of culture than of nature or reality. Such strong social constructionists are thus drawn to what Bhaskar (1994, p. 253; also see Sismondo, 1993, p. 535) calls the "epistemic fallacy," reducing all being or existence to human knowledge. This leads to such startling claims as "the natural world has a small or non-existent role in the construction of scientific knowledge" (Collins, 1981, p. 3). Woolgar (1988) explicitly sides with nominalism against essentialism (which he associates with realism), arguing for a "reversal" of the realist arrow from nature to cognition, in favor of the nominalist–constructionist arrow from cognition to nature. "Objects," he says, "are constituted in virtue of representation . . . representation gives rise to the object" (pp. 55-56, 65).

Eder (1996) sees the "cultural sociology of nature . . . as a way to expunge the latent naturalism from social theory" (p. 20). Social constructionists in environmental sociology have aggressively questioned the realist tradition in terms that reduce it to an equally one-sided, straw argument, devoid of any relation to even a mild constructionism. Thus, Macnaghten and Urry (1998) complain that environmental sciences and much of environmental sociology "rest upon what we have termed the doctrine of environmental realism: that the realm of nature is separate and distinct from that of culture" (p. 16). They claim that most surveys of environmental attitudes on issues like global warming and acid rain reflect "tacit assumptions of 'environmental realism': that environmental risks simply exist 'out there' independently of social practices and beliefs and can thus act as the unambiguous object of individual perceptions, attitudes and values" (Macnaghten & Urry, 1998, p. 89).

In this view, environmental realism and the discourse on sustainable development are characterized as "part of a modernist tradition in which the limits of 'natural' processes can be defined unproblematically by science" (Macnaghten & Urry, 1998, pp. 217-218). Realist environmental sociology is therefore seen as immersed in an ontological fallacy—the contrary of Bhaskar's epistemic fallacy.

Nevertheless, realist conceptions of science and of environmental sociology are at their best far more dialectical than this description would suggest. As Gould (1996) eloquently expressed it, from the standpoint of materialist natural science:

> Science, since people must do it, is a socially embedded activity. It progresses by hunch, vision, and intuition. Much of its change through time does not record a closer approach to absolute truth, but the alteration of cultural contexts that influence it so strongly. Facts are not pure and unsullied bits of information; culture also influences what we see and how we see it. Theories, moreover, are not inexorable inductions from facts. The most creative theories are often imaginative visions imposed upon facts; the source of imagination is also strongly cultural.
>
> This argument, although still anathema to many practicing scientists, would, I think, be accepted by nearly every historian of science. In advancing it, however, I do not ally myself with an overextension now popular in some historical circles: the purely relativistic claim that scientific change only reflects the modification of social contexts, that truth is a meaningless notion outside cultural assumptions, and that science can therefore provide no enduring answers. As a practicing scientist, I share the credo of my colleagues: I believe that a factual reality exists and that science, though often in an obtuse and erratic manner, can learn about it. (pp. 53-54)

Gould's (1996) view here, which eludes both the Scylla of the epistemic fallacy and the Charybidis of the ontological fallacy, is perfectly compatible with the sociology of science standpoint associated with Merton (1957, 1970) in particular. In fact, Merton is frequently referred to in Gould's work (e.g., Gould, 1980, pp. 47-48; Gould, 1987, p. 52; Gould, 1995, pp. 78-80). This kind of "social institutional constructivism" emphasizes the social contexts and institutions that condition science, and it has long been the bedrock of the history as well as the sociology of science (Demeritt, 1998, pp. 176-177).

Social–institutionalist, even materialist, understandings, as Bloor (1991) explains from the standpoint of the "strong programme," are logically compatible with and integrated into the more sophisticated constructionisms (pp. 33-37). In addition to "social institutional constructivism," Demeritt, in his useful fourfold typology of social constructionism, points to two other forms of constructionism that are compatible with realism: "social object constructivism," which emphasizes that social constructs such as gender are just as "real" in their causal effects as reality itself (e.g., Berger & Luckman, 1966), and "artefactual constructivism," which promotes the nondualist view that scientific knowledge is the result of a difficult negotiation between diverse human and nonhuman actors (Haraway, 1991; Latour, 1987).

Where social constructionism becomes antirealist or irrealist—the fourth form of social constructionism in Demeritt's typology—is when it claims (though sometimes as a purely methodological principle) that science and its objects are the product of human action and cognition alone. Demeritt (1998) labels this "Neo-Kantian constructivism" (pp. 176, 178-179).

The debate in environmental sociology thus frequently consists of the difficult task of avoiding both overly naturalistic and overly sociological arguments (Benton, 1994).

Realists (see Norgaard, 1994) in recent years have placed increasing emphasis on the notion of the coevolution of nature and society, while constructionists (see Freudenburg, Frickel, & Gramling, 1995; Irwin, 2001) have been turning to notions of "co-construction."

Environmental feminists, especially those influenced by the historical–materialist tradition, have been fighting wars on two fronts, drawing dialectically on both constructionism and realism, while rejecting one-sided versions of both. These thinkers have insisted on the social construction of gender in the face of biological determinism and essentialism yet have refused nevertheless to give up links to materialism, realism, and science (e.g., Haraway, 1991; Harding, 1991; Merchant, 1992; Soper, 1995). Although insisting that "there is an important sense in which it is correct to speak of 'nature' as itself a cultural product or construction," Soper (1995) observes that "it is not language that has a hole in its ozone layer; and the 'real' thing continues to be polluted and degraded even as we refine our deconstructive insights at the level of the signifier" (pp. 151-152). Furthermore, she insists that a dialectical understanding of the real, material opposition as well as unity of nature and society is necessary to address ecological problems: "I have consistently argued that there can be no ecological prescription that does not presuppose a demarcation between humanity and nature" (Soper, 1995, p. 160).

Recently, Latour, one of the founders of the social constructionist approach to the sociology of science, has also shifted in what some have seen as a more realist direction (Hacking, 2002, p. 17; Sismondo, 1993, p. 537) with his actor network theory, which focuses on the dialectical relation between nature–culture.[4] Indeed, the concepts of "nature" and "culture," he insists, should be replaced by "nature–culture," in which both human actors and nonhuman actors (both now referred to as "actants") are seen as interacting with and mutually constituting one other. This perspective has led Latour at times in a more classically materialist direction. Thus, he argues that "by seeking to reorient man's exploitation of man toward an exploitation of nature by man, capitalism magnified both beyond measure" (Latour, 1993, p. 8). As Latour has moved in this direction, his work has increasingly influenced ecological Marxists (see Braun & Castree, 1998; Castree, 2000; Gareau, 2005).

Marxism in its classical conception was compatible with a sophisticated, critical materialism. Marx was a dialectical thinker, who absorbed much from Hegel and idealist philosophy in general. It is not surprising therefore that his work was highly critical of crude empiricism, mechanism, naturalism, and essentialism (i.e., positivism), while remaining materialist in orientation. Contemporary critical realism has developed on these foundations (Bhaskar, 1975, 1979; Sayer, 1992) and has helped to inspire much of this environmental–sociological analysis (Benton & Craib, 2001; Dickens, 1996; Foster, 2000b; Soper, 1995).

What we are calling here the realist–constructionist approach to the "sociology of ecology" evolves out of this broad critically informed realist tradition and is thus an attempt to understand the social construction of ecological science. Unlike crude naturalism, it takes into account the human construction of knowledge, but unlike the absolutist constructionism of strong idealism, its constructionism always takes account of and is tempered by the "materialist principle," "which derives from the fact that people are themselves material, animal and part of nature such that they are subject to certain of its causal laws and conditions" (Sayer, 1992, p. 34).

This approach can be contrasted to Macnaghten and Urry's (1995; Macnaghten & Urry, 1998, pp. 15-19) conception of the "sociology of nature," which attempts to develop a

"sociology of environmental knowledges" from the opposing idealist–constructionist standpoint. Their work emphasizes how culture influences nature by discursively "reading" (or thinking or speaking) it and that this is not necessarily based in material conditions (Macnaghten & Urry, 1995, p. 210).

In the following argument, as already indicated, we take the Tansley–Smuts debate of the 1930s on ecological holism, which led to the constitution of modern ecosystem science, as our main historical case study. We use a realist–constructionist outlook to explain why a materialist–realist approach to ecology (and environmental sociology) became dominant over its idealist–organicist rival—without in any way denying the historical, contingent nature of this process or that it was inevitably a particular social construction and social struggle. The ecological science that emerged in this period, we suggest, was deeply affected by an "externalist" class–racial conflict and by the competing worldviews of materialism and idealism, as much as it was a direct ("internalist") outcome of the scientific process. The implications of this complex, many-faceted struggle over nature, science, and society remain with us to the present day and have served to shape the contemporary debate on ecology.

From the Sociology of Science to the Sociology of Ecology

The sociology of science is usually seen as having its most important precursor in the work of Boris Hessen. *The Dictionary of the History of Science* depicts Hessen as the originator of the externalist approach to the sociology of science—the broad approach that defined the early history of the field and in which Merton's foundational work was also to fall (Morrell, 1981, pp. 145-146; Shapin, 1981a, pp. 185-186; Shapin, 1981b, p. 262). As J. G. Crowther (1967), an influential science writer, wrote in his *Social Relations of Science*, Hessen's Marxist sociological analysis suddenly "transformed the history of science from a minor into a major subject" (p. 432; also see Cohen, 1990, p. 55).[5]

Hessen was a high-ranking Soviet physicist (director of the Moscow Institute of Physics) and defender of quantum theory and relativity theory at a time in which the Stalinist assertion over science started to call these scientific discoveries into question. In 1931, a Soviet delegation made a surprise visit to the Second International Congress of the History of Science and Technology led by Nikholai Bukharin, one of the leading figures of the Bolshevik revolution and of Marxist thought in the Soviet Union. Bukharin was accompanied by Hessen and other major representatives of Soviet Science—most notably Nikolai Vavilov, the foremost agricultural researcher in the Soviet Union and the discoverer of the original centers of world agriculture and hence the main areas in which the genetic banks for contemporary agriculture are to be found (now known as the Vavilov Areas).

But it was Hessen's (1971) paper on "The Social and Economic Roots of Newton's 'Principia'" that was to have the greatest impact on the conference participants, representing a formative influence in the history and sociology of science and becoming one of the central texts for an important group of British "Baconian Marxist" scientists, including J. D. Bernal, J. B. S. Haldane, Hyman Levy, Lancelot Hogben, Joseph Needham, and Benjamin Farrington (Graham, 1985; Joravsky, 1961; Wood, 1959, p. 145). Hessen presented a sophisticated look at how the necessities of economic production and military development under merchant capitalism led to the concentration on specific material–technological problems, such as crucial elements of navigation, dominating the thinking and general

ethos of scientists at the time. These materialist concerns, he argued, contributed to the mechanistic outlook that played such a large part in Newton's *Principia* and the 17th-century scientific revolution in general.

Hessen's analysis took as its critical point of departure the idealist conception of science, which in the view of Marx and Engels customarily treated "the history of the sciences as if they had fallen from the skies" (Engels to W. Borgius, January 25, 1894, as cited in Marx & Engels, 1975b, p. 441). For Hessen, a more meaningful understanding of the sources of scientific discovery had to be grounded in an understanding of the material conditions—social and economic (and also natural)—in which such ideas evolved. He took as his case Newton's *Principia*—not only the most prestigious work in pre-20th-century physics but the symbol of a pure scientific viewpoint. Demonstrating how practical considerations regarding technology—especially with respect to mining, navigation, and optics—contributed to Newton's mechanistic worldview and how Newton's class perspective affected his thinking, Hessen was able to make a powerful case with regard to external sociological influences on the sciences. Having demonstrated this with respect to Newton, it was easy to establish the same thing with regard to other leading members of the Royal Society, such as Boyle, Hooke, Halley, and Petty, whose practical concerns with technology were much more obvious.

Another important contribution to the sociology of science, emphasizing the social embeddedness of science, was Edgar Zilsel's (1942) classic essay, which emphasized that it was "the rise of the methods of the manual workers to the ranks of academically trained scholars at the end of the sixteenth century [that] is the decisive event in the genesis of science" (p. 558; see also Zilsel, 2000). Just as these mechanical arts, such as metallurgy, could not be discussed without treating their class basis, they could not be dealt with without some recognition that this was where production and nature met. Zilsel's emphasis on the relation between production, class, and the production of science represented one of the most important openings into the sociology and history of science. Zilsel was associated with the social–democratic politics in Vienna prior to the Second World War, emigrating to the United States after Hitler's rise to power. Shapin (1992, p. 339) sees Zilsel's externalist materialist–class account of the origins of science as overlapping with the insights of such historical–materialist thinkers as Hessen (1971), Bernal (1939), Farrington (1949), and Needham (1954). Recently, the "Zilsel thesis" has been revived (see Conner, 2005, pp. 275-282; Smith, 2004, pp. 151, 239).

By far the most important foundational work in the sociology of science originated with Robert Merton (1957, 1970). Merton frequently indicated his intellectual debt to Hessen, although sharply differentiating his own approach to the sociology of science from Hessen's Marxian analysis and adopting a more eclectic approach (Shapin, 1992, p. 342). Beginning with his foundational work, *Science, Technology and Society in Seventeenth Century England* (originally published in 1938 based on his doctoral dissertation and reprinted in 1970), Merton carefully distinguished between the cognitive content of science and its sociological–institutional context (Golinski, 2005, pp. 48-50). His sociology of science deliberately steered away from epistemological questions and from those factors that could be viewed as intrinsic to the scientific method and rational thought generally, which he saw as governed by "universalistic criteria" (in his original formulation, he had said "universalistic facts of nature" [Cole, 1992, p. 4; Merton, 1957, p. 554]). He adhered to the broad conception of the sociology of knowledge that "the social relations in which a man is involved will somehow be reflected in his ideas" and carried this over into the sociology

of science (Merton, 1985, p. 134). But as distinct from the sociology of knowledge (his original area of interest), which was caught up from the beginning in epistemological concerns, Merton attempted to fashion the sociology of science as a largely empirical field concerned with how scientists were influenced by sociological factors, while leaving the actual content of science to be judged by its own universalistic criteria.

In concentrating in this way mainly on the external social–institutional influences, Merton examined both what has been called the "macro-environments of science" (such as political and economic systems and class) and its "micro-environments" (the intellectual milieu, schools of thought, invisible colleges, universities, and colleges, each with their own traditions) (Sztompka, 1986, p. 35).

Merton (1973) was adamantly opposed to the "ivory tower," or the extreme internalist view of science in which scientists were "autonomous god-like creatures" (p. 217). In emphasizing the importance of external influences in his work, he did not thereby create a rigid demarcation between the internal and external but saw them as mediated in complex ways. He made it clear that external influences on science were important but without contending that these were primary with respect to particular scientific discoveries (see Shapin, 1992, p. 337).

Merton's views overlapped with Hessen in arguing that historical developments in technology and social organization provided broad concepts and a social ethos out of which scientific developments, such as Newtonian mechanics, evolved.[6] Science, he recognized, was often a response to material–technological challenges. But he also emphasized, particularly in his famous treatment of the effects of 17th-century English Protestantism on science, that certain socially embedded values, as in the case of religiously derived views that became embedded in the Royal Society, could affect the progress and direction of science even more directly, creating the institutional basis of a scientific community.

In all of this, Merton defended the cognitive core of science as relatively immune from external influences. These influences were seen as constituting no more than the sociological environment of a science that nonetheless adhered to its own rational, universalistic criteria and hence autonomy. As Shapin (1992) explains, "Merton took care to position his thesis between what he saw as the extremes of pure Weberian idealism and the strong materialism that first surfaced in Anglo-American consciousness with Boris Hessen's 1931 [Marxian] account of Newton's *Principia*" (p. 338).

From the formative work of Hessen, Zilsel, and Merton, certain conceptual frames or tools of analysis can be derived, which are used in the following inquiry into the sociology of ecology in the opening decades of the 20th century. Science is not the product of "autonomous god-like creatures," does not "fall from the sky," and is not simply the product of an ivory tower but takes place in a socially embedded context. It is useful to make a distinction between the cognitive content of science and its social context, recognizing, however, that neither can be separated from each other but are mediated in complex, dialectical ways. The sociology of science has often drawn attention to the external, social–institutional context of science at both the macro-environmental (state, economy, ideology, and religion) and micro-environmental (the "invisible college") levels. For materialist–realist sociologists of science, it is reasonable to assume that science attempts to address "universalistic facts of nature." But our understanding of such "universalistic facts of nature" is nonetheless filtered in all sorts of problematic ways through human cognition and praxis. As

Sztompka (1986) points out in his exposition of Merton's views, the objectivity of science is not easily gotten at but is best understood in terms of a "dialectical notion of objectivity"—the product of conflict and passion (pp. 78-79).

Such a "dialectical notion of objectivity" is perhaps best exemplified today by feminist standpoint theory, growing out of the work of such thinkers as Hartsock (1983), Smith (1987), Harding (1991, 1998), Haraway (1991), and Soper (1995). As expounded by Harding (1991), the particular "justificatory approach" identified with feminist standpoint theory

> originates in Hegel's insights into the relationship between the master and the slave and the development of Hegel's perceptions into the "proletarian standpoint" by Marx, Engels, and Georg Lukács. The assertion is that human activity, or "material life," not only structures but sets limits on human understanding: what we do shapes and constrains what we know. (p. 120)

In the Marxian view, knowledge (including scientific knowledge) is conditioned by material–historical development and class position. For feminist standpoint theorists, who, according to Frederick Jameson (1988, p. 64), represent today's "most authentic" heirs to Lukács's (1971) insight, this relates to differing material, lived conditions, and hence knowledge claims of women (as an oppressed–exploited group under patriarchy–capitalism) vis-à-vis those of dominant men. Similar claims can be made with respect to those oppressed in racial terms (Gould, 1996).

According to standpoint theory, knowledge is "socially situated" (Harding, 1991, p. 119). Such knowledge, as Marxist theory taught, is dependent on the development of social relations and social conflict. "Standpoint epistemologies," according to Harding (1991), were evident in the materialist approaches to the social construction of science, between Hessen in 1931 and Zilsel in 1942 (pp. 134-135). Such standpoint theory requires what Harding calls "strong objectivity" combined with a recognition of the historical character of knowledge. Harding describes "weak objectivity" as that form of objectivity that attempts to separate the positive from the normative, science from values. Yet because science is a socially embedded and often an elitist activity, such exclusion of values is impossible. "Strong objectivity," in contrast, attends to the social environment and construction of knowledge and science and hence incorporates a knowledge of the historical background condition into scientific assessments. Its greater reflexivity gives it a stronger objectivity. This is especially true when the understanding of socially embedded conditions that affect dominant knowledge claims arises from the bottom of society, which has *less* interest in supporting prevailing ideologies, reifications.

As Harding (1991) writes:

> The history of science shows that research directed by maximally liberatory social interests and values tends to be better equipped to identify partial claims and distorting assumptions, even though the credibility of the scientists who do it may not be enhanced during the short run. After all, antiliberatory interests and values are invested in the natural inferiority of just the groups of humans who, if given real equal access (not just the formally equal access that is liberalism's goal) to public voice, would most strongly contest claims about their purported natural inferiority. (pp. 148-149)

Strong objectivity for Harding is related to the development of a theoretical perspective that embodies "strong reflexivity," recognizing that what we regard as "nature" is often an embodiment of social relations. Strong reflexivity

> requires the development of oppositional theory from the perspective of the lives of those Others ("nature" as already socially constructed, as well as other peoples), since intuitive experience . . . is frequently not a reliable guide to the regularities of nature and social life and their underlying causal tendencies. (Harding, 1991, p. 163)

In this view, our ontological concepts of nature are often bound to systems of oppression. Thus, Harding (1991), building on the insights of Leiss (1974; also Merchant, 1980), argues that

> science's claim to seek to dominate nature in order to control "man's fate" has actually hidden its real function, and, often, intention: now and in the past, whether scientists intended it or not, science has provided resources for some people's domination of others. (p. 36)

The control of nature (and indeed our very concepts of nature) are therefore open to question, as they are connected to the control of society and its Others.

Feminist standpoint theory is to be contrasted to current trends in the sociology of science, Harding insists, partly because of its emphasis on "powerful background beliefs" that are not so much concerned with the "microprocesses in the laboratory" as the "macrotendencies in the social order" as attendance to the latter is more crucial in the creation of a strong, oppositional reflexivity (Harding, 1991, p. 149).

To address science as a contested realm, as required by notions of strong, dialectical objectivism, requires a view of the development of truth in science (and the demarcation of "good" and "bad" science) that sees this in terms of a dialectical struggle. The sociology of science has generally adhered to a methodological agnosticism with respect to the truth claims of science (though in recent years this has increasingly mutated into an epistemological skepticism and extreme relativism that seemingly undermines scientific knowledge claims). This has served to separate it off from the philosophy of science, which has been concerned in various ways with what distinguishes valid science.

A fully developed critical–historical perspective, however, requires attendance to both sociological background conditions and the truth claims of science. In the following analysis, we rely for heuristic purposes on certain aspects of the philosophy of science view offered by Lakatos in his "methodology of scientific research programmes" and to a lesser extent on the view of scientific revolutions provided by Kuhn (Kuhn, 1962, 2000; Lakatos, 1978). For Lakatos (1978), the "demarcation problem" raised by Karl Popper with respect to the separation of science from pseudoscience cannot be addressed by falsification, as all scientific theories exist within an "ocean of anomalies" (p. 134; Larvor, 1998, p. 50). Nor is it sufficient to take the more relativistic view of Kuhn. Rather, the answer, he contends, lies in the examination of "problemshifts" in the methodology of whole scientific research programs that allow one to determine whether a program is progressive or degenerative.[7]

"A research programme," according to Lakatos (1978),

> is said to be *progressing* as long as its theoretical growth anticipates its empirical growth, that is, as long as it keeps predicting novel facts with some success ("*progressive problemshift*");

> it is *stagnating* if its theoretical growth lags behind its empirical growth, that is, as long as it gives only *post hoc* explanations either of chance discoveries or of facts anticipated by, and discovered in, a rival programme ("*degenerating problemshift*"). If a research programme progressively explains more than a rival, it "supersedes" it, and the rival can be eliminated (or, if you wish, "shelved"). (p. 112)

Of course, the rivalry between research programs can be a very "protracted process," and it is even rational, according to Lakatos, to adhere to a degenerative scientific research program, if it seems possible to turn again into a progressive one. Moreover, the actual fate of scientific research programs cannot be explained simply in terms of their internal logic and development; thus, considerations of "scientific rationality must be supplemented by empirical-external history" (Lakatos, 1978, p. 114).

Lakatos's approach to science overlaps to some extent with that of Kuhn but is clearer in its demarcation of what constitutes progressive science. Lakatos, as Burawoy (1990) pointed out, attempted to supply a theory of the "dynamics of paradigms" that was lacking in Kuhn (p. 777). Although Kuhn (1962) characterizes as "normal science" a situation in which a single paradigm has a kind of monopoly and in which a crisis can develop as anomalies accumulate, resulting in the growth of a rival paradigm and a full-fledged scientific revolution, Lakatos sees "normal science" in this sense as quite rare. Thus, he writes:

> The history of science has been and should be a history of competing research programmes (or, if you wish, "paradigms"), but it has not been and must not become a succession of periods of normal science: the sooner competition begins, the better for progress. "Theoretical pluralism" is better than "theoretical monism." (Lakatos, 1978, p. 69)

Nevertheless, Kuhn (2000) himself insisted that one of the areas in which he agreed with Lakatos was in "our common use of explanatory principles that are ultimately sociological or ideological in structure" (p. 131).[8] In the following analysis, we will try to understand how principles that were "ultimately sociological or ideological in structure" affected, without actually determining, the social construction of ecological science.

The Sociology of Ecology and the Construction of Ecosystem Science

The Double Transference

For environmental sociologists who do not err either on the side of the overnaturalizing of society or the oversocializing (overanthropomorphizing) of nature, the relation between nature and society is dialectical and complex. As Raymond Williams (1980) famously observed, "the idea of nature contains, though often unnoticed, an extraordinary amount of human history" (p. 67). Conversely, the idea of society is often erected on conceptions of nature.

In any attempt to explore this complex nature–society dialectic and its relation to the rise of ecological science in the 1920s and 1930s, it is useful to draw on Marx and Engels's concept of the "double transference" of ideas of nature and society, most evident in their day in social Darwinist thinking. Marx and Engels were strong defenders of Darwin's evolutionary theory, which they viewed as the "death of teleology" in the natural sciences. Yet

they were acutely aware of the fact that Darwin, as he readily admitted, had drawn some of his inspiration from the bourgeois political economy of Smith and Malthus, which they saw as reflecting an alienated society. As Marx wrote to Engels in 1862, "it is remarkable how Darwin recognises among beasts and plants his English society with its division of labour, competition, opening up of new markets, 'inventions,' and the Malthusian 'struggle for existence.' It is Hobbes' *bellum omnium contra omnes*" (Marx & Engels, 1975a, Vol. 45, pp. 106-108).

Neither Marx nor Engels objected strongly in principle to the notion of the "struggle for existence" in nature—though Engels at one time stressed its one-sided character, which excluded cooperation (Marx & Engels, 1975a, Vol. 45, pp. 106-108). Still, there were some problems, as they indicated (Marx & Engels, 1975b, p. 120), associated with the reading of the conditions of bourgeois society into nature—thereby producing one-sided conceptions drawn from alienated society and anthropomorphizing nature in terms of these. Much more serious, however, from their standpoint was the re-extrapolation of these ideas—originally derived from bourgeois society and then imputed to nature—back again to society in naturalized, objectified form, and as eternal natural laws, in a kind of double transference. As Engels was to write in 1875:

> The whole Darwinian theory of the struggle for existence is simply the transference from society to organic nature of Hobbes' theory of *bellum omnium contra omnes* and of the economic theory of competition, as well as the Malthusian theory of population. When once this feat has been accomplished (the unconditional justification for which, especially as regards the Malthusian theory, is still very questionable), it is very easy to transfer these theories back again from natural history to the history of society, and altogether too naïve to maintain that thereby these assertions have been proved as eternal natural laws of society. (Marx & Engels, 1975a, Vol. 25, p. 584; Marx & Engels, 1975b, p. 284; see also Bell, 2004, p. 184)

Engels was not criticizing Darwin's entire evolutionary theory, much less Darwin himself, who never carried out such a double transfer. Rather, he was questioning what was subsequently to be labeled *social Darwinism*, putatively based on Darwin's work and rooted in such naturalistic notions as the "survival of the fittest" (a phrase adopted by Darwin in later editions of the *Origin of Species* from Herbert Spencer).

Engels stressed that the main problem of the social application of arguments derived from Darwin's theory of natural selection was due to the fact that much of Darwin's own theory had originally grown out of attempts to extrapolate social concepts to nature—itself a reasonable enterprise if carried out carefully (for example, Darwin's famous use of the concept of "artificial selection" in introducing "natural selection"). The re-importation of the social concepts of an alienated society, now dressed up in naturalized form, only confounded the problem of social analysis. Indeed, the phenomenon of double transference generated distorted, even sometimes deranged, social interpretations. Thus, social Darwinists such as Herbert Spencer and William Graham Sumner sought to reduce society to eternal biological laws, sometimes of a racist character (Hofstadter, 1955).

Another instance of such a double transfer, Engels was to point out, was to be found in the development of social energetics. The concept of work had been usefully exported to thermodynamics as exemplified in Carnot's analysis of the steam engine. Yet attempts "to

re-import the thermodynamic concept of work back into political economy" were fraught with problems, as were the attempts already being made at this time "to convert SKILLED LABOUR into kilogram metres and then to determine wages on this basis." These efforts failed to recognize that economic–social conditions were dominant in the organization of human labor and could not be reduced to mere energetics (Marx & Engels, 1975a, Vol. 25, pp. 586-587; capitalization in the original; Burkett & Foster, 2008, pp. 133-134).

In the present day, similar double transferences have been introduced as a result of certain reductionist trends in biology, say in the notion of "the selfish gene"—taking ideas from society to explain nature and then re-extrapolating these concepts back again from nature to society in naturalized garb (Dawkins, 1976).

As Bell (2004) has noted:

> metaphors and general patterns of understanding easily flit back and forth between our theories of the realms we label "society" and "nature". . . . Nevertheless, the flitting back and forth of concepts between science and social life deserves special scrutiny because of the way it sometimes allows science to be used as a source of political legitimization. (p. 184)

If the transference of social concepts from the realm of society to that of nature always posed questions (for example, ecologists in the 19th century using the notion of "community" to describe the plant world), such a direct transfer of concepts, it is worth repeating, was certainly not to be excluded outright. Less acceptable, in the view of Marx and Engels, however, was the phenomenon of double transference, which often had the character of a sleight of hand.

It is clear that the issue of a double transference is a major critical issue both for environmental sociologists and sociologists in general. Such transference, especially if metaphorical in nature, can be a source of intellectual inspiration, but it can also if misused lead to the much more questionable anthropomorphization of nature and the naturalization of society. Anthropomorphism is relatively easy to detect, as it usually involves only a single transference rather than going full circle. Here, nature is often seen in terms of the attributes of human beings or human communities—or in a religious context in terms of an anthropomorphic God. In contrast, extreme naturalization is often more difficult to detect, as it frequently involves a double transference and thus has come back full circle. Here, human society comes to be seen as rigidly determined by irrevocable natural laws, which were in fact conceptually modeled after human society.

Marx and Engels's dialectical critique of double transference in the realm of biology, it should be noted, did not extend simply to those who transferred bourgeois competition (i.e., the struggle for existence), to nature, and then in the form of eternal natural law back to human society. They also criticized those such as the Russian social theorist Pyotr Lavrov (a precursor to Kropotkin), who saw nature as one-sidedly cooperative—extrapolating concepts of cooperative human community to nature and then re-extrapolating these to society (Marx & Engels, 1975a, Vol. 45, pp. 106-108). Likewise, they objected to the early 19th-century "true socialist" Rudolph Matthäi's anthropomorphic claim that plants "demand soil, warmth and sun, air and rain for its growth" as a naturalistic model from which to argue for a rational human society. The notion of "demand" here was clearly taken from economics. "The plant," Marx and Engels (1975a) wrote, "does not 'demand' of nature all the conditions of existence enumerated above; unless it finds them already present it never

becomes a plant at all" (Vol. 5, pp. 475-476, 479-481). The methodological objection that Marx and Engels raised here was that of the extrapolation of the economic concept of "demand" to nature and then its re-extrapolation back to society—to create a naturalistic argument in this case in the service of a rational "true socialism." Such re-extrapolations were questionable on both dialectical and materialist grounds—regardless of whether the object was to promote bourgeois society or socialism.

Idealism, especially in its absolutist form, Marx believed, was especially prone to such double transferences in its attempts to incorporate science into its ontology of thought, discovering *Geist* in nature and then re-extrapolating this to society. In Hegel's *Philosophy of Nature*, Marx (1974) observed that nature/matter "is shorn of its reality in favor of human will" or spirit (p. 174). Or as Hegel (1970) himself put it, "the purpose of nature is to extinguish itself, and to break through its rind of immediate and sensuous being, to consume itself like a Phoenix in order to emerge from this externality rejuvenated as spirit" (p. 212). Viewed in these terms, however, nature simply becomes the means to reveal the mind, spirit, human personality, and state: It has no independent existence apart from this anthropocentric, teleological goal. This is, in fact, a double transference: the point at which the Hegelian dialectic was at its weakest. As Auguste Cornu (1957) stated, the problem that Hegel encountered was that "the assimilation of the real to the rational can be carried out by extremely arbitrary procedures" (pp. 437-440). As we shall see, the same problem has bedeviled idealist ecological holism, which is forced into arbitrary constructions in its attempt to assimilate ecology to the mind.

Holism as Superorganism

The notion of the sociology of ecology as we are treating it here is the study of the social construction of ecological science—a polymorphic science that aims uniquely at the dialectical unification of the natural and the social. Our concern, moreover, is to understand the origins of ecological science in ways that directly inform environmental sociology (i.e., the subdiscipline in sociology), which, viewed in realist–constructionist terms, is concerned primarily with the coevolutionary and often crisis-laden relations between nature and society.

Germany's most prominent Darwinian scientist, Ernst Haeckel, coined the word *ecology* in 1866. However, there was hardly any mention of the new term for a couple of decades. Not until 1885 did a book appear with it in its title (Keller & Golley, 2000, pp. 7-9; McIntosh, 1985, pp. 22, 29). Hence, ecology as an organized discipline cannot be said to have existed prior to the early 20th century. In its earliest years, ecological science was dominated by a single scientific research program or paradigm, that of Frederic Clements in the United States. He was a professor of botany and wrote the classic textbook *Research Methods in Ecology* in 1905. Clements provided an idealist, teleological ontology of vegetation that viewed a "biotic community" as a "complex organism" that developed through a process called "succession" to a "climax formation." He therefore presented it as an organism or "superorganism" with its own life history, which followed predetermined, teleological paths aimed at the overall harmony and stability of the superorganism (Clements & Chaney, 1937, p. 51). As he put it in his *Plant Succession*, the "climax formation is an organic entity"—the teleological reality of the superorganism (Clements, 2000, p. 36; Keller & Golley, 2000; Levins & Lewontin, 1985; Worster, 1977). Indeed, "the ecological ideal,"

Clements later stated reflecting Jan Christian Smuts's influence, "is one of wholeness, of organs working in unison within a great organism" (Clements & Chaney, 1937, pp. 47-51).

The strong teleological character of Clements's analysis gave it necessarily a neo-Lamarckian character. As Ronald Tobey (1981) explains, Clements

> believed that plants and animals could acquire a wide variety and range of characteristics in their struggles to survive, and that these features were heritable. In the 1920s, he thus engaged in Lamarckian experimentalism, which ended in failure by the 1930s. (p. 182)

Altogether characteristic of Clements and his followers was the use of the notions of ecological "community" in ways that sometimes seemed to anthropomorphize nature and to impute a teleology to such "communities"—attributing to them "mysterious organizing properties" (Levins & Lewontin, 1985, p. 135).

Although Clements's organicist perspective dominated plant ecology for half a century, in the 1920s and 1930s rival paradigms arose—those of individualistic, probabilistic, population theory (represented by Henry Gleason) and ecosystem ecology (represented by Arthur Tansley)—that were largely to supersede it. Each of these approaches represented stark alternatives since rooted in fundamentally different ecological ontologies. Clements's teleological model saw the natural environment as a superorganism. Gleason's more reductionist approach based on individuals focused on random processes and probabilistic events in the environment. Tansley's conception of ecosystem projected a materialist holism of a kind radically opposed to the teleological holism of thinkers such as Clements.

The transformation of Clementsian teleological holism in ecology from a progressive to a degenerative research program (in Lakatos's terms) was evident when it encountered a huge anomaly in the great Dustbowl drought of the 1930s, which resulted in a crisis in the theory and a sharp contraction of its empirical content (Tobey, 1981, pp. 213-221). At the same time, it began to merge with a more hierarchical model aimed at human society as well—in the work of Jan Christian Smuts, John Phillips, and John William Bews in South Africa, with whom Clements came to be aligned. A crucial factor in this shift, as in the work of Smuts and Phillips, was the attempt to construct an ecological view that combined teleological holism with ecological racism, in terms that seemed ultimately aimed at justifying the latter in a kind of double transference—what might be termed *social Clementsianism*. This led to an intellectual war between idealist and materialist approaches to ecology, and their respective versions of holism, that has persisted in various fashions in ecological science and ecological thought ever since.

When the smoke cleared in the 1930s and 1940s, it was ecosystem ecology that had come to represent the new progressive scientific research program. Idealist, teleological approaches persisted as degenerative programs, marginalized within science, though always threatening to stage a comeback. In what follows, we explore the sociological construction of the understanding of nature in a historical materialist–ecological context and how issues of ecological racism, materialism versus idealism, and the question of double transference came to play a central role in this understanding. The importance of both realism and constructionism—indeed the significance of a realist–constructionist approach—will be highlighted.

Ecological Holism and Racial Hierarchy: Jan Christian Smuts

Inspired by Clements's ecology and by Whitman, Spinoza, and Darwin, Jan Christian Smuts coined the term *holism* as a means of describing nature–ecology (Ansbacher, 1994, p. 486). Smuts shared his vision of nature with South African botanists/ecologists John William Bews and John Phillips and the Clementsian tradition in ecology. Building on Smuts's holism and the notion of succession in grassland evolution, Bews (1925) wrote *Plant Forms and Their Evolution in South Africa*, thanking Smuts for guidance and inspiration. Eager to establish his "holism" concept in the scientific world, Smuts (1926) himself then wrote *Holism and Evolution*, a book that was to lead to modern conceptions of deep ecology.

The ecological holism proposed by Smuts emerged out of his position in South African politics. Referred to as General Smuts because of his military role in the Boer War (he fought on the side of the Afrikaners), he was one of the principal figures in establishing the preconditions for the apartheid system. Smuts himself coined the word *apartheid* (meaning literally apartness) in 1917—almost a decade before he coined the word *holism*. Ironically, although Smuts has often been viewed as a "moderate" in the context of White South African racial politics, he has also been referred to as the "architect" of apartheid (Harvey, 2001, pp. 36-38). He was a strong advocate of the territorial segregation of the races and what he called "a grand [white] racial aristocracy" (Smuts, 1940, pp. 2-3). He indicated at one time that he had a simple message: to "defy negrophilists." He is perhaps best remembered worldwide as the South African general who arrested Gandhi. Smuts tried to impede the flow of immigrants from India, imposed martial law against labor strikers, and deported labor leaders from the country (Anker, 2001, pp. 45-47; Davenport & Saunders, 2000, pp. 244-245; Hancock, 1962, pp. 325-347).[9]

Smuts was the South African minister of defense from 1910 to 1919, and prime minister and minister of native affairs from 1919 to 1924 and 1939 to 1948. He was sometimes seen as a figure soaked in blood. When the Native Labour Union demanded political power and freedom of speech, Smuts crushed it with violence, killing 68 people in Port Elisabeth alone. When Black Jews in Bull Hoek near Queenstown refused to work on Passover, Smuts sent in the police and close to 200 people were killed on his orders. In 1922, when Black tribal populations in Bondelswart refused to pay their dog tax and complained about White penetration of their lands, Smuts sent in planes and bombed them into submission (Anker, 2001, pp. 46-51; Davenport & Saunders, 2000, pp. 292-293; Lindqvist, 2000, Section 107). Horrified by these actions, the South African poet Roy Campbell (1930) was propelled to write the poem "HOLISM," which included the following lines:

> The love of Nature burning in his heart,
> Our new Saint Francis offers us his book—
> The saint who fed the birds at Bondelswart
> And fattened up the vultures at Bull Hoek. (p. 103)

The "new Saint Francis" was Smuts; "his book" was *Holism and Evolution*. Although Smuts (1926) asserted that "we do not want to recreate Nature in our own image," his concept of holism was grounded in the social–political climate of South Africa, and it represented a transfer of social relations to nature and back again to society (p. 21). It embodied issues of domination and control. He argued that life is a process of change and evolution

is a creative process. Rejecting the perceived rigidity of mechanism (or mechanistic materialism), Smuts sought a universal principle to explain the organization of both nature and society. He argued that "all organisms feel the force and moulding effect of their environment as a whole" (Smuts, 1926, p. 340). At the same time, the whole is self-active and operates under its own inherent activities. For him, the world comprised an ongoing, evolving series of wholes, which are constantly interacting. For each whole, the parts are in constant interaction, sustaining a dynamic equilibrium. The parts act to fix and repair any damage to the whole, because they are subordinate to the whole (Smuts, 1926, pp. 80-82).

Holism and Evolution starts with three premises. First, life evolved from matter. Thus, matter as life (reflecting its emergent evolution) is no longer bound by mechanistic principles of motion and energy. Instead, matter has become a realm of life and the entire world is alive through progressive developments. Second, the natural world is essentially beneficent and moves toward constant improvement, which involves cooperation, service, and order. Third, the universe is concerned and guided by the principle of holism. The production and advancement of wholes is part of the essence of life. For instance, "the creation of wholes, and ever more highly organised wholes, and of wholeness generally as characteristic of existence, is an inherent character of the universe" (Smuts, 1926, p. 99).

In arguing that evolution was a process of creating ever more complex and important wholes and establishing that there was a hierarchy, Smuts was able to order and divide the world into a hierarchy of wholes, from low to high species. He assumed that evolution was a series of ordered advances toward greater perfection. The organism was the center of control, given that this was the site of the development of personality. As opposed to Darwinian natural selection, Smuts (1926) contended that the higher, teleological process of

> Holistic Selection is much more subtle in its operation, and *is much more* social and friendly in its activity. . . . Its favours go to those variations which are along the road of its own development, efficiency, and perfection. (p. 213)

Nature's hierarchy was then seen as directly "social and friendly"—or cooperative.

Within the hierarchy of wholes, there was a hierarchy of personalities (another level of wholes). This was Smuts's famous concept of "personalogy," which he related to his ecology. The notion of superior personalities, such as Geothe and Whitman (themselves proponents of the organicist vision that appealed to Smuts), as the highest form of life was a view that seemed to present an almost religious striving (Anker, 2001, pp. 72, 191-192). Smuts (1932b) declared "man is in very truth an offspring of the stars"—a quasireligious view that was meant to stand in opposition to materialism (pp. 17-18). This outlook was influential with Alfred Adler, Freud's great opponent within psychology. Adler argued that "a body shows a struggle for complete wholeness" and saw this as connected to Smuts's emphasis on personality and holism (Adler, 1964, p. 68; see also Ansbacher, 1994, p. 491).

The most advanced, complex wholes (personalities), in this view, had greater independence (freedom) from the immediate environment. The less advanced did not have the same degree of freedom and control over their environment, which they could not socially construct to meet their needs and ends. Such people remained at the mercy of nature—they were seen as "children of nature." The hierarchy in the natural and social world was the

result of natural development. Inequalities between races were the result of natural inequalities rather than social structures and social history. Life tended toward ever-greater perfection and goodness (Smuts, 1926, pp. 297-313).

Although *Holism and Evolution* was primarily abstract in its discussion, the lectures that Smuts presented at Oxford in 1929 on Africa were much more explicit with respect to his position on natural and racial relationships, and they help us to understand the connections between his hierarchical, teleological ecology, in which nature itself is turned into a hierarchy of wholes—in which a human stratification (based on the notion of personalogy) is erected—and his role in laying the foundations for apartheid in South Africa. There is no doubt that the naturalized hierarchy that constituted Smuts's theory of ecological holism gave seeming philosophical–scientific support to his racial views. Indeed, as one critic of Smuts, the South African ecologist Edward Roux, indicated, in Smuts's holism, which followed on his concept of apartheid, "segregation was raised to a philosophy" (as quoted in Anker, 2001, p. 191). Smuts prepared his Oxford lectures to counter those who questioned the presence of Europeans in Africa and their right to influence African development. As a politician centrally involved in the organization of the League of Nations, he framed White European interest in Africa in naturalized, "humanitarian" terms, even when advocating outright racism. W.E.B. Du Bois (1947), many years later, when Smuts pleaded for an article on "human rights" to be adopted by the United Nations, did not miss the "twisted contradiction of thought" being revealed, given that Smuts had "once declared that every white man in South Africa believes in the suppression of the Negro except those who are 'mad, quite mad'" (p. 43).

Smuts presented the colonial explorations of Livingstone and Stanley as early Europeans seeking to bring civilization to the people of Africa. He asserted that their historic mission must be continued to save Africa from barbarism (Smuts, 1930, p. 43). In fact, Smuts (1930) argued that Great Britain must take a humanitarian and commercial interest in Africa and that this would further civilize this land (p. 32). Labor would be recruited from various African nations. But this development would also raise new questions regarding what happens "wherever a superior culture came in contact with a lower, more primitive. We cannot mix the two races, for that means debasement of the higher race and culture" (Smuts, 1930, p. 30).

Smuts argued that Blacks naturally lacked an internal impetus for creating the world. In his ecological theory, they were seen as lacking the evolutionary development of a complex (climax) personality—a notion that represented a complex, double transfer from society to nature (via Smuts's holism) and then back again. Thus, it was the duty and right of Europeans to organize the social and natural structure of Africa. In an account that drew on the concept of "recapitulation" (ontogeny follows phylogeny) as employed within 19th-century biological racism, Smuts (1930) wrote:

> It is even possible, so some anthropologists hold, that this was the original mother-type of the human race and that Africa holds the cradle of mankind. But whether this is so or not, at any rate here we have the vast result of time, which we should conserve and develop with the same high respect which we feel towards all great natural facts. This type has some wonderful characteristics. It has largely remained a child type, with a child psychology and outlook. . . . There is no inward incentive to improvement, there is no persistent effort in construction, and there is complete absorption in the present, its joys and sorrows. Wine, women, and song in their African forms remain the great consolations of life. No indigenous religion has been evolved,

> no literature, no art since the magnificent promise of the cave-men and the South African petroglyphist, no architecture since Zimbabwe (if that is African). Enough for the Africans the simple joys of village life, the dance, the tom-tom, the continual excitement of forms of fighting which cause little bloodshed. They can stand any amount of physical hardship and suffering, but when deprived of these simple enjoyments, they droop, sicken, and die. . . . These children of nature have not the inner toughness and persistence of the European, nor those social and moral incentives to progress which have built up European civilization in a comparatively short period. . . . It is clear that a race so unique, and so different in its mentality and its cultures from those of Europe, requires a policy very unlike that which suit Europeans. (pp. 75-76)

Smuts's reference to adult Africans as "children" drew on the recapitulation theory in biology, which had been widely adopted in the late 19th century but was already falling out of favor at the time Smuts was writing and has long since been rejected by modern biologists.[10] Recapitulation was the notion that each individual of a species in its development passes through (recapitulates) in telescoped fashion the main stages that the entire species over historical time had previously passed through. The recapitulation theory was often used, as in Smuts's case, to propound theories of biological racism. As Stephen Jay Gould has described the frequent racist use of the concept:

> For anyone who wishes to affirm the innate inequality of races, few biological arguments can have more appeal than recapitulation, with its insistence that children of higher races (invariably one's own) are passing through and beyond the permanent conditions of adults in lower races. If adults of lower races are like white children, then they may be treated as such—subdued, disciplined, and managed (or, in the paternalistic tradition, educated but equally subdued). The "primitive-as-child" argument stood second to none in the arsenal of racist arguments supplied by science to justify slavery and imperialism. (Gould, 1977, p. 126; see also Gould, 1996, pp. 142-151)

Building on recapitulation theory and his own racist–ecological–holism, Smuts proposed that separate and parallel institutions and segregation were required to save and retain African wholeness. He argued that this policy would help preserve racial purity, by preventing miscegenation, and would maintain a healthy, good society. Any unnatural mixing of the people, contravening the natural, hierarchical principles would lead to the moral deterioration of the species. He argued:

> The old practice mixed up black with white in the same institutions; and nothing else was possible, after the native institutions and traditions had been carelessly or deliberately destroyed. But in the new plan there will be what is called in South Africa "segregation"—separate institutions for the two elements of the population, living in their own separate areas. Separate institutions involve territorial segregation of the white and black. If they live mixed up together it is not practicable to sort them out under separate institutions of their own. Institutional segregation carries with it territorial segregation. The new policy therefore gives the native his own traditional institutions on land which is set aside for his exclusive occupation. . . . For urbanized natives, on the other hand, who live, not under tribal conditions but as domestic servants or industrial workers in white areas, there are set aside native villages or locations, adjoining to the European towns. . . . This separation is imperative, not only in the interests of a native culture, and to prevent native traditions and institutions from being swamped by the more

> powerful organization of the whites, but also for other important purposes, such as public health, racial purity, and public good order. The mixing up of two such alien elements as white and black leads to unhappy social results—racial miscegenation, moral deterioration of both, racial antipathy and clashes, and to many other forms of social evil. (Smuts, 1930, pp. 92-93)

In Smuts's intellectual system of apartheid–holism–apartheid, we therefore find signs of a double transfer. Natural hierarchy (modeled on social hierarchy) is used to justify social hierarchy and social hierarchy is used to give meaning to natural hierarchy in a never-ending whole. His ecology gives rise to a complex or climax personality that was a manifestation of notions of racial hierarchy—and meant to further justify racial hierarchy. Smuts (1930, p. 76; see also Smuts, 1932a, pp. 127-130) contended that Africans, in contrast to Europeans, were "children of nature," lacking the drive for social "progress." Thus, Europeans must enact special policies to "conserve what is precious" about Africa and Africans (Smuts, 1930, pp. 33, 75-78). The racial differences of society were attributed to nature and then re-extrapolated back to society to justify extreme segregation (apartheid). The whole conception is mirrored after a view of dominant personalities as the model for natural–social domination, within a teleological perspective. For Smuts, ecology was the science and justification for this new holism that naturalized social control.

Smuts saw his work as countering materialist approaches to science. The reception of *Holism* within British science was so strong as to catapult him to president of the British Association for the Advancement of Science (BAAS). In his 1931 presidential address to the BAAS, he attacked the physicist John Tyndall's famous 1874 presidential address to the Association (which was much admired by Marx and Engels [1975a, Vol. 45, p. 50]) as an "unrestrained expression" to the "materialistic creed" (Smuts, 1932b, p. 10; Tyndall, 2000). For Smuts nature in any truly meaningful sense (beyond mere "brute fact") was to be seen as a construction of the mind:

> Great as is the physical universe which confronts us as a given fact, *no less great is our reading and evaluation of it in the world of values. . . . Without this revelation of inner meaning and significance the external physical universe would be but an immense empty shell or crumpled surface*. The brute fact here receives its meaning, and a new world arises which gives to nature whatever significance it has. As against the physical configurations of nature we see here *the ideal patterns or wholes freely created by the human spirit* as a home and *an environment for itself*. (Smuts, 1932b, pp. 12-13, emphasis added)

These views put Smuts in an idealist camp that saw the physical universe as "an immense empty shell" apart from mind and the "pattern of wholes created by the human spirit" as its own environment. He was thus seen as one of the great British Empire idealists, along with such figures as Whitehead, Bradley, Collingwood, John Alexander Smith, Lloyd Morgan, and John Scott Haldane (Anker, 2001, pp. 137-143; Tobey, 1981).[11] Karl Popper (1962) viewed Smuts as a Hegelian evolutionary idealist (pp. 29, 304-305).

Smuts's ecological holism was enormously influential. In particular, John Phillips, a South African grasslands ecologist, incorporated Smuts's as well as Clements's holism into his own ecological studies (Phillips, 1954). In Phillips's (1932) construction of the natural world, humans were part of a biotic community that was filled with cooperation and harmony. At the same time, human beings were naturally organized in a racial hierarchy.

The fact that these two ideas coexisted within a single construction is no accident, since as Anker (2001) notes, "Phillips coined the term 'biotic community' to designate this ecocentric ethics and environmental social policy of segregated ecological homelands" (p. 192). Phillips argued in his scientific writings on ecology that natives should not be granted any autonomy or freedom because it would violate the relations of races within the community. The "ruling races" were to regulate the stock of natives to prevent excess grazing and degradation of the environment. In Phillips's racist biocentrism, miscegenation between the lower European stock and the natives was to be avoided to prevent the degeneration of biological diversity. Women's desire for freedom should be constrained and large families among Whites should be encouraged (Anker, 2001, p. 148; Phillips, 1932, pp. 51-72).

In his *Human Ecology*, John Williams Bews (1935), another South African ecologist and follower of Smuts, contended that some humans were determined by the conditions of their environment, whereas other humans were more independent of their environment. This argument developed out of Smuts's theory regarding certain organisms and personalities being more independent and strong, versus those that were affected by the environment. Bews spoke of "the ecological division of mankind" as necessitating "the segregation of the races." In his 1931 article on the "Ecological Viewpoint," he transferred the concept of natural hierarchy modeled on human society back to human society, speaking of a "climax type of men" exemplified by "the small white population in South Africa" (Anker, 2001, p. 167; Bews, 1931, p. 4; Bews, 1935, pp. 18-20, 54, 155, 256). Those primitive peoples who were still tied to the "Earth-mother," he argued, should be left as much as possible in their own proper biotic communities. Bews also insisted that marriage was the only natural relation between men and women and that homosexuality was ecologically and morally wrong. Smuts's holism thus reinforced naturalized ecological–racist views. At the same time, Clements, and other ecologists in the United States, became strong defenders of Smuts's and Phillips's ecological holism (Anker, 2001, pp. 171-175).

Materialist Ecosystem Analysis: Arthur Tansley

General Smuts's teleological, holistic philosophy together with its racial implications engendered the ire of both socialists and consistent materialists–realists. Smuts's legendary opponent in the great "Nature of Life" debate that took place at the BAAS meetings in South Africa in 1929 was the British Marxist biologist Lancelot Hogben. Hogben then occupied a position at the University of Cape Town. Not only did he debate Smuts—opposing his own materialism to Smuts's holism and attacking Smuts for his racial eugenics—but Hogben also hid Black rebels fleeing the racist state (in which Smuts was such a dominant figure) in a secret compartment in his basement (Anker, 2001, p. 122). Hogben viewed Smuts's holism as a more sophisticated version (incorporating notions of emergence) of the vitalism ("creative evolution") of Henri Bergson and others. In opposition to this, he presented a mechanistic materialism and agnosticism on the nature of life and the world in general. Although there were deep issues of materialism and science involved, Hogben made it clear that his opposition stemmed in large part from a perception of the dialectical perversion associated with Smuts's ecologically racist holism. As he observed in his book *The Nature of Living Matter*, organized around his 1929 debate with Smuts and his followers,

> the benign and tolerant humanism which [the ancient materialist] Epicurus grafted on the soil prepared by the atomists was ill suited to flourish in the stern climate of the [Hellenistic] military state. Like [Smuts's] holism, Aristotle's [Hellenistic] system was a shrewd blending of science and statesmanship. It enabled its author to combine a personal predilection for natural history with a political partiality for slavery. (Hogben, 1931, p. 224)

Another major opponent of Smuts, and one who was directly to influence Tansley, was the British Marxist mathematician Hyman Levy, who, in *The Universe of Science*, developed a critique of Smuts's holism along similar lines to those of Hogben, elucidating a materialist systems theory in response (Levy, 1933). Levy's (1938) own ecological interests were evident in *A Philosophy for a Modern Man*.

However, the central figure in opposing the ideas of Clements, Smuts, Phillips, and Bews in ecology was Arthur Tansley, a moderate or Fabian-style socialist, the first president of the British Ecological Society and the originator of the ecosystem concept.[12] Tansley, significantly, had been a student of biologist Ray Lankester at University College, London.

Lankester was Thomas Huxley's protégé and was considered the greatest Darwinian scientist of his generation. He was also the most adamantly materialist biologist of his day in Britain. When he was a boy, Darwin had carried him on his shoulders. As a young professor, Lankester was a close friend of Karl Marx and an admirer of Marx's *Capital*. He was the only English mourner among the few attendants at Marx's funeral. Lankester considered himself a socialist, though of the more Fabian variety (Gould, 2003, pp. 113-129; Lester, 1995). He was also to become one of the most ecologically concerned thinkers of his time and wrote some of the most perceptive and eloquent essays that have ever been written on species extinction because of human causes, discussing the pollution of London and other ecological issues with an urgency that was not found again until the late 20th century (Foster, 2000a; Lankester, 1913, pp. 365-372). Lankester was an adamant opponent of vitalism, authoring a preface to a book criticizing Bergson's *élan vital* (Lankester, 1912).

The young Tansley was deeply influenced by Lankester, along with the botanist Francis Wall Oliver, in his years at University College, London. Like Lankester, Tansley was an adamant materialist. And like Lankester, Tansley was to challenge directly attempts to conceive evolutionary ecology in antimaterialist, teleological terms.

The fact that the natural environment that ecologists like Tansley encountered in Britain was overwhelmingly "second nature," in the sense that all of it had been transformed by human beings, may have brought to mind evolutionary materialist issues of ecological crisis and sustainability—in ways that a more untouched, "pristine nature" as encountered in the colonies (or former colonies) did not. For Clements, Smuts, and Phillips, who drew from their contemplation of the relatively "untouched" grasslands of the United States and South Africa, a teleological conception of nature (the historic role of indigenous peoples in the management of these environments was still not understood—or better denied, especially in Smuts's hierarchy where indigenous peoples remained at the mercy of nature), this all seemed perfectly "natural." But for Tansley, the leading ecologist in the British Isles, the environment with which he had to deal was only "seminatural" at best, affected at every point by human intrusions and transformations (Tansley, 1926, pp. 21-25).

Although a professional botanist and plant ecologist, Tansley was far from being a narrow specialist and was engaged as well with psychology and philosophy. In 1920, he

published his book *The New Psychology* on Freud's psychoanalysis and how the human mind was affected by the laws of biology, which became a bestseller and went through 11 editions (Tansley, 1920). In 1922, with the help of Ernst Jones, Tansley went to Vienna to study with Freud and to undergo psychoanalysis by Freud himself. Freud referred two clinical patients to Tansley whom he treated for years. For many years, Tansley was considered one of the leading British experts on Freud's psychoanalysis. His work on ecology frequently drew analogies from psychology. As late as 1952, in his *Mind and Life*, Tansley continued to attempt to synthesize the basic elements of existence within a framework that encompassed both psychology and ecology (Tansley, 1952).

Tansley considered himself a scientific realist but also one who recognized that our understandings of nature were constructed (what would today be called a "mitigated scientific realism" or "critical realism") (Keller & Golley, 2000, p. 12). Adhering strongly to the materialist principle but recognizing social constructionism, he argued, to a largely idealist audience at the Magdalen Club at Oxford, that even if one were to suppose "that a large part of the Universe *is* arranged [presumably by God] to fit the scientist's ambition," it was nonetheless true that such natural systems could be considered "real phenomena—that they are *there* and are not mere figments of our fantasy" (as quoted in Anker, 2001, pp. 141-142).

In 1935, Tansley found himself increasingly at odds with antimaterialist constructions of ecology that were then gaining influence, and he entered the fray against ecological idealism. It was at this time that he wrote his historic article for the journal *Ecology* titled "The Use and Abuse of Vegetational Concepts and Terms," which declared war on Clements, Smuts, and Phillips and introduced the new concept of "ecosystem" (Tansley, 1935). The term *abuse* in the title was meant to convey Tansley's objection to the direction ecological "holism" was taking. The immediate target of Tansley's critique was a series of three essays (and particularly the third of these on "The Complex Organism") by Phillips, in which the latter had attempted to advance the case of Clements and Smuts against materialists like Hogben (Phillips, 1935).

Phillips's organicist constructions raised the ire of Tansley, and in one fell swoop in his *Ecology* article, he attacked a whole set of teleological notions propagated by Clements, Smuts, and Phillips: (a) that ecological succession was inherently progressive and developmental, leading to a climax; (b) that vegetation could be seen as constituting a superorganism; (c) that there was such a thing as a "biotic community" (with members), encompassing both plants and animals; (d) that "organismic philosophy," which saw the whole universe as an organism, was a useful way to understand ecological relations; and (e) that holism could be seen as both cause and effect of everything in nature—and extended to society.

Smuts's holistic teleological view, Tansley pointedly asserted, was "at least partly motived by an imagined future 'whole' to be realised in an ideal human society whose reflected glamour falls on less exalted wholes, illuminating with a false light the image of the 'complex organism'" (Tansley, 1935, p. 299). This was a polite way of referring to the system of racial stratification, which was built into Smutsian holistic ecology. For Tansley, Clements, Smuts, and Phillips had to differing degrees carried out a questionable extrapolation of anthropomorphic social concepts (in the case of "plant communities" and climax personalities) to nature and then had re-extrapolated these concepts to society. In Tansley's case, the principal objection was how this promoted racist notions. Indeed, as historian Anker (2001) contends, Tansley, in the passage quoted above, was "referring to Phillips's racist biocentrism and the politics of holism . . . with its treatment of 'less exalted wholes'

at, for example, Rand, Bondlewaart, and Bull Hoek" (the sites of three massacres of native Africans ordered by Smuts) (p. 153).

In combating this type of idealist holism and superorganicism and introducing the concept of ecosystem in response, Tansley (1935, p. 300) turned to the dialectical systems theory used in Levy's *The Universe in Science*, tied to new developments in physics, and at the same time referred to materialist conceptions of dynamic equilibrium in natural systems going back to Lucretius (Epicurus's Roman follower and author of the great philosophical poem *The Nature of Things*). "The more fundamental conception," represented by his new "ecosystem" concept, Tansley (1935) argued, was that of

> . . . the whole *system* (in the sense of physics), including not only the organism-complex, but also the whole complex of physical factors forming what we call the environment of the biome—the habitat factors in the widest sense. Though the organisms may claim our primary interest, when we are trying to think fundamentally we cannot separate them from their special environment, with which they form one physical system. . . . These *ecosystems*, as we may call them, are of the most various kinds and sizes. They form one category of the multitudinous physical systems of the universe, which range from the universe as a whole down to the atom. (p. 299)

Following Levy, Tansley emphasized a dialectical conception of abstraction:

> The systems we isolate mentally are not only included as parts of larger ones, but they also overlap, interlock and interact with one another. The isolation is partly artificial, but is the only possible way in which we can proceed.[13]

Moreover, Tansley (1935) argued that it was somewhat "arbitrary and misleading" to remove climatic factors from any consideration of the ecosystem and that the relation between organisms and the environment was "reciprocal" (p. 300). Nature, in Levy's and Tansley's conception, was not to be viewed as seamless but, on the contrary, had certain natural seams in its fabric, delineating interactive subsystems of the whole (isolates) that were open to analysis (Tobey, 1981, pp. 177-178). Tansley (1935) thus wrote that "whole webs of life adjusted to particular complexes of environmental factors, are real 'wholes,' often highly integrated wholes, which are the living nuclei of *systems* in the sense of the physicist" (p. 297).

Rather than seeing such ecological "wholes" in terms of a natural, teleological order, he emphasized contingency and constant disruptions to any kind of natural stasis, referring to "the destructive human activities of the modern world" and presenting human beings especially as an "exceptionally powerful biotic factor which increasingly upsets the equilibrium of preexisting ecosystems and eventually destroys them, at the same time forming new ones of very different nature" (Tansley, 1935, p. 303). Thus, human beings were capable of "catastrophic destruction" in relation to the environment (p. 289).

Tansley's view of ecosystem disruption by human beings thus introduced a notion of widespread crisis of ecosystems emanating from anthropogenic causes. "Ecology," he argued, "must be applied to conditions brought about by human activity," and for this purpose, the ecosystem concept, which situated life within its larger material environment, and penetrated "beneath the forms of the 'natural' entities," was the most practical form for analysis (Tansley, 1935, p. 304). In his comprehensive study, *The British Islands and their*

Vegetation, Tansley put forward a dynamic point of view, in contrast to Clements's model of succession and climax. He explained:

> the position of relative equilibrium, corresponding with what I have called the mature "ecosystem," is the fundamental ecological concept. . . . "[P]ositions of equilibrium" are seldom if ever really "stable." On the contrary, they contain many elements of instability and are very vulnerable to apparently small changes in the factor-complex. Recognition of "positions of stability" is a necessary first step in the understanding of vegetation. The more important sequel is study of the factors which maintain or disturb and often upset them. (Tansley, 1939, p. vi)

Tansley's ecosystem concept was, arguably, more genuinely holistic and more dialectical than the relatively rigid superorganicism and "holism" that preceded it because it brought both the organic and inorganic world within a more complex materialist, Darwinian-style synthesis.

Tansley recognized that the conditions of nature were a product of both natural and human history (Tansley, 1939, pp. 194-195). Through analyzing pollen deposits in layers of peat, he studied how the advance and retreat of glaciers influenced the distribution of plants in a given geographic area (pp. 149-164). Disturbance was recognized as an important factor in plant composition—as were historical changes in climate, soil conditions, and animal populations. Tansley highlighted how all of these relationships interacted and influenced the historical succession (or regeneration) of plants in a particular environment. Thus, nature, itself, through systematic study, influenced Tansley's conception of ecosystems.

Natural processes and cycles operate, influencing the growth of plants within a particular historical context, while at the same time human encroachment increasingly transformed nature. Tansley (1939) explained:

> With his increasing control over "nature" the human animal became a unique agent of destruction of the original ecosystems, as he cleared and burned natural vegetation and replaced it with his pastures, crops and buildings. Limited at first to the regions where civilization originally developed, this destructive activity has spread during recent centuries, and at an increasing rate, all over the face of the globe except where human life has not yet succeeded in supporting itself. It seems likely that in less than another century none but the most inhospitable regions—some of the extreme deserts, the high mountains and the artic tundra—will have escaped. Even these may eventually come, partially if not completely, under the human yoke. (p. 128)

Draining the fens and deforestation—to create pastures—radically modified the natural conditions, such as soil fertility, and changed the distribution of plants. Tansley (1939) indicated that such alterations led to the "establishment of a new ecosystem, [which was] the result of the original factors of climate and soil together with the modifying factors which [humans] introduced" (p. 128). Through studying the disturbance, transformation, regeneration, and destruction of nature, Tansley developed a dynamic conception of ecosystems.

Tansley's dialectical rejection of a system of natural–holistic harmony, however, was rooted, as it had been for other thinkers before him, such as Darwin and Marx, in his materialism. "The Use and Abuse of Vegetational Concepts and Terms" referred to Lucetius (Epicurus) citing Lucretius's *On the Nature of the Universe*. Tansley, like many other

thinkers in the materialist and scientific traditions, was inspired by the ancient Epicurean materialist critique of teleology and religion and transformed this into a critique of Smuts's holism (Anker, 2001, p. 299).

For Tansley (1935), Phillips's articles, which sought to develop the teleological ecology of Clements and Smuts, "remind one irresistibly of the exposition of a creed—of a closed system of religious or philosophical dogma. Clements appears as the major prophet and Phillips as the chief apostle, with the true apostolic fervour in abundant measure" (p. 285). Phillips, according to Tansley (1935), had "recourse to scientific *arguments*" only "here and there," relying for the most part on "the pure milk of the Clementsian word" (p. 285).

Nowhere was the existence of a closed, idealist–teleological model of nature more evident than the insistence on the inherently progressive nature of succession, always pointing toward the climax state. In contrast, Tansley argued, in contradistinction to Clements, that there was also such a thing as "retrogressive succession"—a succession (in time) that led away from the climax system. In this way, Tansley's ideas paralleled those of his mentor, Lankester, who had rejected all teleological interpretations of evolution, famously arguing that degeneration was possible in the evolutionary process. Nonetheless, Tansley continued to argue from a systems perspective, for a "dynamic ecology" that was organized around the general tendency toward dynamic equilibrium in ecosystem development. This, he claimed, was "the ecology of the future" (Tansley, 1935, pp. 287-288, 304-305; see also Tansley, 1939).

As in the case of Hogben, Tansley's rejection of the ecological ideas of Smuts and Phillips seems to have been motivated as much by the dislike of ecological racism as by his opposition to ecological idealism. When Smuts delivered his lectures on Africa and race at Oxford in 1929, Tansley was in the audience and given what we know of the latter's views was almost certainly not impressed. Tansley belonged to a group of thinkers, including H. G. Wells and Julian Huxley, who saw ecology as standing for a more rational approach to human society and nature. Wells and Huxley had coauthored (with G. P. Wells) the important work *The Science of Life*, first appearing in 1929, which had provided a materialist ecological vision (Wells, Huxley, & Wells, 1934). Both Wells and Huxley were close friends with Hogben, while Tansley was closely connected to Huxley (Anker, 2001, pp. 248-250). In this context, Wells's judgment on Smuts's ecological racism doubtless reflects the view of all of these thinkers. As Wells (1939) wrote in *The Fate of Man*,

> It is one of the good marks in the checkered record of British Imperialism that in Nigeria it has stood out against the development of the plantation system and protected the autonomy of the native cultivator. . . . But against that one has to set the ideas of white-man-mastery associated with Cecil Rhodes and sustained today by General Smuts, which look to an entire and permanent economic, social and political discrimination between the lordly white and his natural serf, the native African. And this in the face of the Zulu and Basuto, the most intelligent and successful of native African peoples. The ethnological fantasies of Nazi Germany find a substantial echo in the resolve of the two and a half million Afrikanders to sustain, from the Cape to Kenya, an axis of white masters . . . with a special philosophy of great totalitarian possibility called holism [the philosophy introduced by Smuts], lording it over a subjugated but more prolific, black population. The racial antagonism makes the outlook of South Africa quite different from that of most of the other pseudo-British "democracies." Obviously it is not a democracy at all, and plainly it is heading towards a regime of race terrorism on lines parallel and sympathetic with the Nazi ideal. (pp. 191-192)

Smuts, as a leading figure within the British Empire, opposed the Nazis and led South Africa in declaring war on Germany. But Wells was not off base in seeing in the philosophy of Smuts's holism, with its ecological justification of developing apartheid, the foundation of what might be called a philosophy of ecological apartheid—akin in some ways to the "ethnological fantasies" and extreme racial oppression (and exterminism) of Hitler's Germany. Without question, it was such concerns about ecological hierarchy and racism that brought out the very sharp differences between the two scientific research programs and their respective constructions of ecology.

Tansley stuck adamantly to materialist–realist constructionism. He insisted that ecology must be seen in terms of dialectically interrelated, dynamic systems (ecosystems) that were free as much as possible from the prior imposition of teleological concepts and the smuggling in of social concepts that were meant to reinforce rigid social hierarchies through the re-extrapolation of these concepts in naturalized form back into society. All forms of anthropomorophization of nature (the direct, as opposed to metaphorical, transferences of human–social characteristics to nature) were suspect. Ecology should not be seen as a reflection of the glamour of grand human personalities "on less exalted wholes." In his materialist–realist construction of an ecological worldview, Tansley thus rejected both anthropomorphism in the analysis of nature and naturalistic justifications for racial oppression in human society. At the same time, he insisted on the fact that human beings could be destructive forces in nature—as revealed in his studies of changes in plant distribution and transformations in ecosystems—undermining ecological systems. Rejecting an idealist–teleological approach to ecology, he directly challenged such theories in terms of their empirical realism: "What researches," Tansley (1935) rhetorically asked, "have been stimulated or assisted by the concept of 'the complex organism' *as such*?" (p. 305).

Both sides of this debate, it should be noted, were concerned with promoting conservation in the face of human ecological destruction. Tansley became the first chairman of the British Nature Conservancy and the most consistent advocate for the creation of nature reserves in Britain (McIntosh, 1985, p. 299; Tansley, 1945). Smuts proposed a system of nature reserves in South Africa. But in line with the ecological racism that was an intrinsic part of Smuts's ecological holism, Smuts naturally saw this as carrying over into a conception of reserves for native Africans themselves. Smuts's holism was as H. G. Wells (1939) intimated: "a special philosophy with great totalitarian responsibility," rooted in a double transference (pp. 191-192). Smuts's clear ambition was to be a grand legislator over both society and nature within what was to become the apartheid system.

Materialism Versus Idealism in Ecology's Formative Period

In many respects, this conflict between teleological holism in ecology and ecosystem ecology may be regarded as inevitable, quite apart from questions of race. The conflict over the meaning of ecological holism in one form or another has been one of the crucial tasks of ecological thought. Ironically, one well-known treatment of ecological paradigms has argued that "the materialistic revolution in ecology" associated with Tansley's ecosystem concept carried forward "the first ecological ideal Clements's superorganism, [which] is not dead, but rather transmogrified into a belief that holistic study of ecosystems is the proper course for ecology" (Simberloff, 2000, p. 77). Although more reductionist

approaches to ecology existed, ecological science gravitated toward holistic answers of one kind or another.

Tansley's own approach has been described as a "nonteleological mechanistic holism" (Keller & Golley, 2000, p. 176). Ecology demanded either an idealist organicism and holism, such as what was provided by Clements and Smuts, or a materialist holism, which grew out of Tansley's concept of ecosystem. The evolution of Clementsian ecology into a form propounded by Smuts and Phillips—a development supported by Clements (1936) himself—however, marked the distorted bias of teleological holism when it sought to expand into a truly holistic vision connected to human society.

Clements and Smuts developed rigidly hierarchical notions of the ecological world, drawn from society, which were then re-imposed in the case of Smuts and his followers back on society—in the form of a system of ecological apartheid. The resulting intellectual system was incoherent to an extreme, hamstrung by its own teleology. Phillips sought to link Smuts's teleological holism directly with that of social Darwinists in sociology, such as Spencer and Sumner, with whom there were many political–social similarities, but was thwarted by the possessive individualism of the social Darwinists, which did not fit easily with a more Aristotelian holistic perspective (Phillips, 1935).

The holism of Smuts and Phillips (and Clements) ran up against problems in incorporating empirical observations, limited as this perspective was by its essentially linear, teleological thrust. As Phillips (1935) put it, "succession is progressive only" (p. 505). But the explicit insistence on the teleological "progressive only" in relation to ecological succession marked the degeneration of the organicist research program, as it went against Darwinian conceptions of evolution, which explicitly reject such teleological notions. It also declared by mere fiat what needed to be determined empirically. Not surprising, then, Phillips (1935) wrote the following: "General Smuts' need for refinement and for extension of his theme is more and ever more facts, interrelated facts, suggestions and soundly based ideas regarding organisms, communities and the changing stage—the habitat—on which they play their part" (p. 489).

But the incorporation of empirical considerations and even more the generation of a research program that would anticipate novel facts within a dynamic, natural–historical set of relationships was certainly not a strength of teleological holism within ecology, as it assumed that all empirical data would have to fit within its procrustean bed. After Clements's early analyses, the intellectual progress of the teleological paradigm stalled. The failed attempt to merge ecological holism of this kind with sociology, particularly of a racist variety, and to implement this as policy in Smuts's South Africa contributed to the degeneration of the entire research program associated with holism, if only by encouraging the development of a considerable materialist ecosystem ecology in opposition. Smuts's attempt to carry out a double transfer had the effect of destroying whatever genuine insights the notion of ecological "holism" contained.

In the Popperian philosophy of science, the downfall of a paradigm is attributed to some crucial experiment or crucial anomaly. In Clements's case, the anomaly is supposed to be observations on the development of the prairies in the United States during the drought of the 1930s, which followed a pattern other than what Clementsian succession had supposed. The severe drought associated with the Dust Bowl of the 1930s, dramatized in John Steinbeck's (1939) *The Grapes of Wrath*, was experienced as a refutation of Clementsian ecology and resulted—in the process of trying to account for the anomaly—in a severe

contraction of the paradigm's empirical content, the sign of a degenerative research program in Lakatos's terms (Keller & Golley, 2000, p. 28; Tobey, 1981).

Popperian disproofs, based on anomalies, however, are rarely conclusive. Clementsian ecology might have absorbed that anomaly, as it at least attempted to do, as just one of what Lakatos has called "an ocean of anomalies" affecting all sciences. The real reasons for the organicist–holist paradigm's downfall are more directly related to its ultimate research objectives. It projected a holism that pointed to the existence of a "superorganism." The very teleological orientation of this perspective created insoluble problems that became ever more apparent as the hierarchical–teleological analysis was extended into the social realm. It became "theoretically exhausted" and unable to grapple with the complex, contradictory changes taking place in the real world (Tobey, 1981, pp. 213-221). The teleological, equilibrium-oriented, neo-Lamarckian approach to ecology represented by the hierarchical model of superorganicism and holism was ill equipped, as we have seen, to deal with the advent of ecological crises, such as the 1930s Dust Bowl, or the destructive aspects of human intervention in the environment (and society). Its linking to philosophic apartheid in the work of Smuts and Phillips likely only added to its problems. Hence, this research program increasingly took on the form of a degenerative research program, in Lakatos's sense—one that was hindered by its idealism, its theoretical anthropocentrism, and its hierarchical social content. As Leiss (1974) explained, "the domination of nature" has always been about the domination of society (and domination within society). Nowhere was this more evident than in Smutsian holism.

In contrast, the progressive research program associated with Tansley's ecosystem ecology gained ground as part of what Simberloff (2000) called a "materialistic revolution." Beginning with the ecosystem concept, it evolved into a general systems theory in ecology. Tansley's ecosystem analysis, arising within plant ecology, was rooted in studying the disturbance, transfer, destruction, and growth of plants in relation to dynamic, historical–natural conditions, such as changes in climate and soil fertility. His science and ecosystem concept was fundamentally informed by his studies of plant history and emergent nature. Tansley's ecosystem ecology easily connected up with work on animal ecology developed by Tansley's friend Charles Elton. This approach was given an enormous boost by the publication of Raymond Lindeman's famous article "The Trophic-Dynamic Aspect of Ecology," which incorporated energy flows into the ecosystem model (Lindeman, 1942; McIntosh, 1985, p. 196).

Increasingly, ecosystem analysis merged with thermodynamic perspectives coming out of classical physics. In the work of Eugene and Howard T. Odum (sons of sociologist Howard W. Odum), ecosystem analysis was integrated with a more general systems ecology evolving out of the notion of metabolic interactions between organisms and their environments (Golley, 1993; Hagen, 1992, pp. 100-107). Indeed, the emphasis on metabolism lined up (though not explicitly) with Liebig's proto-ecological reflections on capitalist industrialism and the robbing of the soil, which inspired Marx's ecological–materialist concept of the "metabolic rift" (Dickens, 2004; Foster, 1999). Ecosystem analysis was also broadened to take into account the analysis of the biosphere that had emerged in the work of the Russian biogeochemical–ecological thinker Vladimir Vernadsky. When Rachel Carson and Barry Commoner stormed on to the public stage in the 1960s and 1970s, their analysis was rooted in a materialist understanding of ecosystems, which had become the new holism, reflecting its greater heuristic power and its greater attention at the same time

to fundamental disjunctures and crisis—no longer was a "balance of nature" presupposed (Carson, 1998; Commoner, 1971; see also Foster & Clark, 2008).[14]

Yet the victory for materialist ecosystem analysis was never really complete and the defeat for teleological holism never irreversible. The two general paradigms continued to struggle in different ways. In the case of the ecosystem program, there was always the danger that it would degenerate as all mechanical materialisms are wont to do into a form of mechanical reductionism (Berry, 2000; Levins & Lewontin, 1985; Lewontin & Levins, 2007). Its very technical facility was seen as leading it in a reductionist and hence ultimately unecological direction. In the case of the organismic approach of teleological holism, it derived new strengths within the ecology movement and on the margins of science through its influence on deep ecology, which also adopted aspects of ecosystem ecology. Here, the influence of Smuts persists.[15]

Smuts's holism, as we have seen, was embraced in the psychology of Alfred Adler. Adler sided with Smuts over Hogben in relation to the "Nature of Life" controversy in South Africa. He arranged for *Holism and Evolution* to be translated into German. Adler seized on Smuts's notion of "wholes as self-acting, self-moving organisms," embodying a particular purpose and direction to become more complete wholes, as his own basis for formulating an "internal principle of action" (i.e., a "law of movement") as a natural basis for "human goal striving" (Stepansky, 1983, p. 254). He actively promoted Smuts's perspective to colleagues and friends.[16] Smuts's ideas were thus incorporated into the discussions around Gestalt psychology.

It was no doubt in relation to Adler that Arne Naess, the cofounder of deep ecology, was introduced to Smuts's ideas, having studied in Vienna in 1934, when Smuts's ecological holism and its psychological connections were being promoted by Adler (Anker, 2001, pp. 180-181; Bottome, 1957, pp. 83-84). Deep ecology carried forward many of the essentialist, vitalistic, and organismic traditions of the idealist side of the ecological debate. It ended up being more influential in environmental ethics than ecological science, though frequently crossing over into the latter.

The continuing tensions around the social construction of ecological science are revealed by the fact that the influential environmental historian Donald Worster presents Tansley in his magnum opus *Nature's Economy* as the principal source of ecological error and the founder of not only mechanism but also reductionism in ecology. Worster comes out strongly in favor of the "organismic trends in science" represented by Bergson, Morgan, Whitehead, and Smuts: the whole "resurgence of philosophical idealism" in this area in response to mechanistic materialism (Pepper, 1996, pp. 233-234, 242-245; Worster, 1977, pp. 301-304, 316-323; see also Barbour, 1995). For Worster, the "New Ecology" stretches from Tansley and Elton to the Odums and represents a massive extension of the technical means for controlling nature. In this respect, he argues, the organicist tradition is needed as a kind of ethical counterbalance.[17]

A similar position is taken by leading ecofeminist historian and theorist Carolyn Merchant (1980), who writes that

> holism was proposed as a philosophical alternative to mechanism by J. C. Smuts (1926) in his book *Holism and Evolution*, in which he attempted to define the essential characteristics of holism and to differentiate it from nineteenth-century mechanism. . . . 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. (p. 292-293)

Uncritically embracing Smuts's holism, Merchant (1980) identifies it with the development of ecology itself: "The most important example of holism today is provided by the science of ecology" (pp. 292-293). In contrast, Tansley's work, though occupying a far more important place in the history of ecological science, is dismissed by Merchant as giving rise to purely mechanistic, computer-driven models: "The reductionist ecology of Arthur George Tansley, developed in the 1950s [sic.], has matured into the 'Club of Rome's' computer model, which predicts the 'limits to growth' for the entire world system" (p. 252).

In fact, the contradiction between teleological organicism and mechanistic materialism was insurmountable and narrowly constraining on both sides. Although the materialist tradition provided the more powerful scientific research program, it was often weakened by mechanism and reductionism. And although the teleological holist tradition often seemed more dialectical (though its teleology ultimately undercut that), it had little in the way of a solid material grounding. The answer, we believe, lies in a nonteleological, dialectical materialist ecology. During the 1930s, 1940s, and 1950s, figures such as Haldane, Needham, Bernal, Hogben, Levy, Farrington, and Zilsel in the historical materialist tradition struggled over these issues, which can be shown as foreshadowing the later work of American Marxist contributors to biology and ecology, such as Gould, Lewontin, and Levins (Clark & York, 2005b; Werskey, 1978). Probably the best example of this is Levins and Lewontin's (1985) *The Dialectical Biologist*.

Toward a Realist Constructionism in Ecology and Environmental Sociology

Our argument here is that environmental sociology cannot afford to embrace a strong social constructionism and to expel realist views. Indeed, a sociology of ecology that can serve as a counterpart to environmental sociology must embody a degree of realism. At the same time, a crude positivism that ignores epistemology and social construction in favor of naturalistic determinism is worse than useless. Neither the epistemic fallacy, which reduces ontology to epistemology, nor the ontological fallacy, which reduces epistemology to ontology, is acceptable. Ecological analysis in general depends on the development of a strong dialectical objectivism or dialectical critical realism—what we have termed here *realist constructionism* (Bhaskar, 1993). To address earthly questions regarding the social–nature relation requires such an approach to grapple with the history and emergence of a dynamic world.

A sociology of ecology, geared to the needs of environmental sociology in particular, will be most effective, we have argued, if it takes the form of a realist constructionism. This necessitates what Harding (1991) calls a "strong objectivism," which does not simply include the adherence to certain objectivist criteria within science but also recognizes the fact that knowledge including science is socially situated—and hence can only fully be understood and evaluated in its broad development (through historically specific analysis). Today's attempts to evaluate the relative significance of Smuts's and Tansley's contributions to environmental social thought (e.g., Merchant, 1980; Worster, 1977) have suffered

from a lack of knowledge of the historical construction of these ideas—how they arose in a process of conflict and contradiction and how this affected their respective worldviews.

In treating the ecological world, Marx insisted that "the nature that preceded human history . . . is nature which today no longer exists anywhere (except perhaps on a few Australian coral islands of recent origin)" (Marx & Engels, 1975a, Vol. 5, p. 40). Nevertheless, he also argued on material–realist grounds that there were fundamental ecological constraints (for example, soil metabolism) on which human society depended. The materialist principle remains crucial for all ecological and ecological–social analysis. Hence, both historical constructionism and realism were essential in an ecological materialist analysis. Marx and Engels considered Darwin's evolutionary theory to be a breakthrough in the materialist–realist interpretation of natural history. But they warned of the effects that certain bourgeois ideas, such as the "struggle for existence," competition, and overpopulation, might have if transferred to nature and then transferred back to society as eternal natural laws.

In the end, there can be little doubt that the presence of a teleological conception of nature and a double transference (particularly with respect to race) constituted Tansley's main realist–constructionist objections to Smuts's ecological holism. Smuts, the coiner of the words *holism* and *apartheid*, used his concept of ecological holism to provide a philosophical–scientific justification for the apartheid system for which he helped lay the foundations. For Tansley, Smuts not only transgressed against a materialist conception of nature, but he also transgressed against a materialist–humanist conception of society. Smuts's idealism saw nature–ecology not so much as a reflection of the human mind as a reflection of dominant personalities (and races), which represented the apex in a new hierarchical scale of nature. As an ecological research program, Smuts's idealistic holism was unable to compete with Tansley's materialism, as the latter sought to construct/explain nature in terms of its own complex systems and processes, linked to close empirical analysis, rather than as a prefigured teleological philosophy of succession (Clements) or a philosophy of segregation (Smuts). Tansley was not philosophically naïve, recognizing that ecosystems were "isolates" on the model of physics but nonetheless ones that were not entirely arbitrary, as following nature's seams.

The Tansley–Smuts conflict in the construction of ecological science points not only to the importance of realism but also to the value of "externalist" or social–institutional approaches to the sociology of science, concentrating on relations of class, production, power, ideology, and the general social ethos, as exemplified in different ways by the approaches of Hessen and Merton. For all the advances made in recent years in the sociology of science through the examination of the microcontext of the laboratory, a broad social–institutional approach that deals with the larger social background conditions of science remains crucial. Rather than focusing on assorted reifications that distort any conception of science, they remind us to focus on the big issues of alienation, exploitation, and oppression—the reflexive issue, as Harding says, of "Others." For example, where there is a struggle over race in society, this struggle is likely to be replicated in science (see Gould, 1996). And although this in itself does not give us the means of judging science itself, it aids us in developing more dialectical conceptions that allow us to understand the ways in which reality and reason can be distorted.

In the light of Smuts's idealist dialectic of holism and apartheid, one is reminded of Sayer's (1992) realist–constructionist methodology, which argues that

> it is not just the *ideas* (of racial differences etc.) behind *apartheid* in the abstract that are wrong but the actual practices (enforcement of pass laws, etc.) and material structures (segregated and materially deprived townships, etc.) which reciprocally-confirm, legitimate and are legitimated by those ideas. (p. 40)

Likewise, "criticism," as in the case of apartheid, "cannot reasonably be limited to false ideas, abstracted from the practical context in which they are constitutive, but must extend to critical evaluation of their associated practices and the material structures they produce and which in turn help to sustain those practices" (Sayer, 1992, p. 40). A sociology of ecology thus has to be forever attuned to the ways in which nature is used in struggles over human society and the consequences of this, as well as to the human exploitation of nature in the service of such social exploitation.

The dialectical realist constructionism that we have been defending here can be contrasted to the skeptical or irrealist constructionism that has lately come to influence environmental sociology. One manifestation of this has been a tendency to argue that the global ecological crisis, phenomena such as global warming, is socially constructed and that it is therefore subject to varying interpretations based on different conceptual schemes or discourses. The truth claims of scientific reports in this area are thus declared to be discursive and "uncertain" (Taylor & Buttel, 1992; Yearly, 1991).

Nevertheless, from the standpoint of dialectical–realist constructionism, it might be said, in Vician terms, that we can understand the reality of global warming because we have really made it. The physicist Tyndall first discovered as a result of laboratory experiments in 1862 that carbon dioxide created a kind of greenhouse effect, heightening the temperature near the earth's surface (Weart, 2003, pp. 3-4). Throughout the century and a half since, we have learned that the phenomenon of global warming is occurring because of anthropogenic causes. The reality of global warming as well as our reflexive historical awareness of it is the outcome of the dialectical process of the coevolution of human society and nature, of which science is a part (Clark & York, 2005a). Such a perspective requires that we avoid giving too much power to our mere conceptions while neglecting extradiscursive reality. As Soper (1995) has said, "it is not the discourse of 'global warming' or 'industrial pollution' that has created the conditions of which it speaks" (p. 249). The agenda of a new sociology of ecology concerned with the historical–sociological roots of our scientific understanding of ecology derives its imperative (as does environmental sociology) from the need to confront the planetary crisis that "surrounds us," one which is also a product of our own social juggernaut (Clark & York, 2005a; Foster, 2002).

There is an unavoidable tension between those who argue that nature is principally to be viewed as constructed and those who claim that nature is a reality that is in some sense independent of our constructions. These two views, as Soper (1995) claims, must be held in "productive tension," allowing us to engage the realist constructionism necessary for a sociology of ecology.

Notes

1. More recent notions of "reflexive modernity" transcend the realist–constructionist divide by in a sense abolishing the distinction. Such approaches are perhaps too quick to accept "the end of nature" (i.e., the "end of nature" as independent of human beings) and thus to translate environmental crises into questions of pure

"risk" to be fully acceptable to most environmental sociologists, who are disinclined to believe that nature has in any sense "ended" and are concerned rather with the dialectical relations between nature and society (see Giddens & Pierson, 1998, pp. 204-217).

2. In presenting these three principles in this form, we have taken certain liberties in all three of the "quotations" here. The notion that Galileo reached down and touched the earth and said "it still moves" is of course the stuff of legend but can be taken as a fundamental principle of realism (Hart, 1978, pp. 102-104). Vico (1984) argued that in contradistinction to the natural world, which, since "God made it, he alone knows," the "world of nations" was one that "since men . . . made it, men could come to know" it (p. 96) (see also Marx, 1976, p. 493). This can be seen as the fundamental principle of historical–humanist–constructionism. Marx (1963) stated that "men make their own history, but they do not make it just as they please; they do not make it under circumstances chosen by themselves, but under circumstances directly encountered, given and transmitted from the past" (p. 15). This is the fundamental principle of historical materialism. We have expanded it to encompass natural–environmental conditions as well. All three of these principles are central to what we refer to in this analysis as "realist constructionism."

3. As this quote indicates, "realism" is sometimes presented as an epistemological position and materialism as an ontological one. Bhaskar (1989) defines realism as "the theory that the ultimate objects of scientific inquiry exist and act (for the most part) quite independently of scientists and their activity" (p. 12). Realism thus points to a materialist ontology. Consequently, there is no consistency in distinguishing realism and materialism even among critical realists, with Bhaskar (1983a, 1983b) using both terms to cover basically the same conceptual range but with somewhat different emphases—so that one can also refer to a materialist epistemology and a realist ontology. We therefore use the terms somewhat interchangeably in this article, giving preference to "realism" in the specific context of the "realism" versus "constructionist" debate itself and giving preference to "materialism" where the polarity to be stressed is that of "materialism" versus "idealism."

4. In the famous "epistemological chicken" debate between Collins and Yearly (1992) and Callon and Latour (1992), Latour and Callon are presented as philosophical radicals who are shifting away from "social realism" (starting from the social nature of truth) toward "natural realism" (starting from natural objects). Latour and Callon, however, claim that their actor–network theory cannot be seen as subservient to traditional "natural realism" of science in that it is aimed at questioning an ontological understanding that even at the level of basic vocabulary is rooted in human-centered terms. Many social–ecological theorists therefore see this kind of radical questioning as liberatory.

5. The impact that Hessen had on sociologists, historians, and philosophers of science is dramatized by the fact that the personal library of one of the authors of this article includes a copy of the 1971 edition of *Science at the Cross Roads*, containing Hessen's paper. The book was previously part of the library of sociologist Edward Shils (1910-1995), a major contributor to the sociology of science. It was sent to Shils by the distinguished chemist and philosopher of science Michael Polanyi (1891-1976). This copy of *Science at the Cross Roads* still contains a printed card that says "with the compliments of Michael Polanyi." Significantly, the card was found (when the book came to one the authors of this article) on the opening page of Hessen's essay.

6. Merton's relation to Hessen was complex. Although distancing himself from Hessen's Marxian views and his strongly materialist externalism in the sociology of science, Merton nonetheless openly defended Hessen against those who sought to discard his insights completely (see Merton, 1939). What was to be the most influential part of Merton's classic *Science, Technology and Society in Seventeenth-Century England* addressed Protestantism and its influence on science and thus has sometimes been thought of as somewhat Weberian in emphasis. But the second part of this work focused on the materialist–technological conditions (what Zuckerman [1989] has called "The Other Merton Thesis"). This part of the analysis, as Merton (1970, pp. 142-143, 185-187, 201-206) himself was at great pains to point out, was concerned with the economic and materialistic interpretation of history, inspired by Hessen's, if somewhat "crude," Marxian analysis.

7. Although Lakatos normally refers to research programs as "progressive" or "degenerating," we often follow Kuhn (2000) in his treatment of Lakatos in referring to the latter form as "degenerative" (p. 132).

8. Despite the fact that Kuhn thought of himself primarily as an internalist, concerned with the logic and historical development of scientific rationality in its own terms, he was well acquainted with classical externalist contributions by sociologists, having carefully studied Hessen, Merton, and Zilsel (Kuhn, 2000, p. 287).

9. A crucially important source for our analysis of the debate between Smuts and Tansely, and the divisions in ecology in this period, is Peder Anker's (2001) landmark work *Imperial Ecology: Environmental Order in the British Empire, 1895–1945*. Anker's analysis of the political divisions associated with the ecological debate

represented by Smuts and Tansley is far superior to earlier accounts, as in Tobey (1981). Anker's research is concerned with two different models of ecological and social management in the empire. Ours is focused on the materialist versus idealist origins of ecological science in this period and its implications for a sociology of ecology (and for the field of environmental sociology); hence, we draw on different materials and arrive at different (but not necessarily divergent) conclusions.

10. In *Holism and Evolution*, Smuts (1926) incorporated the "ontogeny recapitulates phylogeny" theory in support of his theory of holism (pp. 74, 115).

11. John Scott Haldane was J. B. S. Haldane's father. The latter was a staunch materialist and one of the Baconian Marxists.

12. Like his contemporaries Wells and Julian Huxley, Tansley was a moderate socialist or social democrat and an adamant materialist. He believed in what he once called a "semi-socialist society." His views thus overlapped in certain critical areas with those of noted British radical scientists of his day, such as Bernal, Haldane, Hogben, Levy, and Needham. However, he was strongly critical of the Soviet Union and what he perceived as its "totalitarian" manner of organizing scientific research. During the famous "social function of science" debate of the 1940s, Tansley was one of the two founders of the Society for Freedom in Science, which opposed the proposals of Bernal and others on the social organization of science (Anker, 2001, pp. 22, 224; Werskey, 1978, pp. 281-282).

13. The crucial role of abstraction (alongside the concept of internal relations) in dialectical thinking is discussed in Ollman (2003, pp. 59-112). It is noteworthy that Ollman (1976, p. 286) emphasizes the impact of Levy on his own thinking.

14. In a study of international environmental treaties from 1870 to 1990, David John Frank (1997) empirically demonstrated "the world-level rise and consolidation of the scientific ecosystem model of nature in the post-World War II period" (p. 428).

15. Ironically, some ecological theorists and historians have suggested that the organicism and holism represented by Clements and Smuts persists in the work of ecological systems theorists such as Eugene Odum. Yet Odum's systems ecology is viewed as descending from the materialist ecosystems analysis initiated by Tansley rather than the philosophical idealism and conception of climax communities propounded by Clements and Smuts (see Barbour, 1995; McIntosh, 1980, pp. 204, 243; Simberloff, 2000, p. 77). The teleological view represented by Smuts can also be seen in the work of such figures as Fritjof Capra (1996). Such analysis tries dialectically to transcend the idealist–materialist divide in the interest of a broader ecological holism.

16. Adler's journal published a translation of Smuts's 1931 presidential address to the BAAS, which had defended scientific idealism (Ansbacher, 1994, p. 490).

17. In his later *Wealth of Nature*, Worster (1993, p. 1975) writes much more positively of Tansley, and Smuts is no longer posed as an alternative.

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