Civilization's Wake: Ecology, Economics and the Roots of Environmental Destruction and Neglect

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> In general the prospects are bleak. A combination of unfavourable circumstances could all too easily lead to the classic symptom of disruption within and between countries and societies. Conflict, famine, disease and breakdown are not uncommon in history, and could creep upon us as they have crept on others, lurching from crisis to crisis until they become unmanageable.
>
> *(Tickell, 1992, 72)*

> The new human species, *homo ecophagus,* is a ubiquitous, predatory, omniecophagic species that is a malignant epiecopathologic process engaged in the conversion of all planetary material into human biomass or its support system with coincident terminal derangement of the global ecosystem.
>
> *(Hern, 1990, 35)*

> The cause of our present sickness is our modern technological civilization and its underlying ideologies.
>
> *(Sheldrake, 1990, 178)*

> Man has lost the capacity to foresee and to forestall. He will end by destroying the earth.
>
> *—Albert Schweitzer (quoted in Laura & Ashton, 1991, 8)*

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ECONOMICS AND THE ROOTS OF ENVIRONMENTAL NEGLECT

In this article we will examine some of the ecological and social ramifications of the thesis that one of the principal ideological sources of our present environmental crisis is orthodox neoclassical economics. Insofar as economic agents approximate "rational economic men" maximizing their expected utility in a global technoindustrial capitalist system embodying such values, environmental degradation will occur. According to this view, often associated with radical environmentalism and "deep ecology" (Naess, 1973; Manes, 1990), it is our present growth-based economic system which lies at the heart of the environmental crisis. This view has been argued for by many (for a review see Lyons et al., 1995) but a particularly clear expression of this sentiment is given by the deep ecologist Andrew McLaughlin in *Regarding Nature: Industrialism and Deep Ecology* (1993). McLaughlin notes that the present day ills of industrial economies such as unemployment and urban poverty are blamed on lack of economic growth by our politicians and mainstream economists. Consequently unemployment and urban poverty can only be cured by increasing industrial production. However, if there is a global ecological crisis then increased economic growth arguably (arguments below) leads to increased environmental destruction and increased resource use. Consequently we are faced with a "fateful dilemma": "Either we pursue economic growth and ecological collapse, or we seek ecological sustainability and economic collapse" (McLaughlin, 1993, p. ix).

We will explore this dilemma here, arguing that there is a genuine and irreconcilable conflict between the operation of global capitalism and the demands of ecological sustainability. The focus of this essay is upon economics and economic systems and the roots of environmental neglect. Other factors contributing to the environmental crisis such as third world population growth will not be considered here as we have considered them elsewhere (Smith et al., 1997). Our second qualification concerns the nature and rationality of capitalism. We define capitalism to be an economic system in which "(1) the optimal division of labor is so advanced that most people produce for the needs of others, (2) the means of production and the capacity to work are owned privately, and (3) there are markets in both" (Przeworski, 1992, p. 2). So-called communist and socialist societies have failed to achieve not only ecological sustainability but economic sustainability as well; as the economist Howard Wachtel has stated, communism is no longer an *ism*, it is a *wasm* (Viederman, 1993, p. 179). However even if we accept that capitalism is the "only game in town", it does not follow that this game is "rational" or sane. Eric Fromm in *The*

Sane Society (1956) described how it was possible for an entire society to be "insane." Modern technology has given us the capacity to enrich everybody's life with the best of past and present literature and culture but "these media of communication, supplemented by advertising, fill the minds of men with the cheapest trash, lacking in any sense of reality, with sadistic fantasies which a halfway cultured person would be embarrassed to entertain even once in a while" (Fromm, 1956, p. 5). We believe that a telling form of this systems-irrationality is seen in the environmental arena. Due to the power/interest structures of global capitalism and the juggernaut-like momentum of the global economy (Smith et al., 1997) it is most unlikely that any of the radical changes to society and the economy proposed by environmentalists—especially changes in philosophies and world views—will be adopted in time if the limits to growth literature is correct. Consequently we have come to believe that human civilization—primarily Western technoindustrial urban society—will self-destruct, producing massive environmental damage, social chaos and megadeath. This pessimistic futurology has been discussed by us in a number of books (Lyons et al., 1995; Smith et al., 1997). Here we restate our general argument using more recent sources.

In the next section we will discuss the eschatological consequences of the limits to growth debate. In the third section we will show that environmental economics has severe theoretical and practical shortcomings. In the fourth and final section of this chapter we address some deeper foundational questions underlying this debate. Science and technology are not a *deus ex machina* that will save us just in the nick of time from the environmental crisis as technological optimists believe. Indeed science and technology today have merged into global capitalism and have become an essential part of it. We agree with radical critics of science such as Sheldrake (1990) that an ecologically sustainable world will require a "greening" of science and an abandonment of reductionism (Smith, 1984) but we also see little chance of this occurring. Modern humans have lost sight of the fragility of human life, society and science. We will pay dearly for this folly.

THE LIMITS TO GROWTH

The concepts of *growth* and *development* must be carefully distinguished because they are logically distinct concepts with their own sense. This distinction is not observed by cornucopian economic critiques of environmentalism such as Wilfred Beckerman's *Small is Stupid: Blowing the*

Whistle on the Greens (1995). *Growth* is the *quantitative* increase in the rate of flow of matter-energy through the economy, resulting in an increase in the scale of the physical dimensions of the economy. *Development* is "the qualitative improvement in the structure, design, and composition of physical stocks and flows, that result from greater knowledge, both of technique *and of purpose*" (Daly, 1987, 323). Consequently, an economy can develop, but not grow, and grow but not develop. There can also be limits to growth and limits to development. As we noted elsewhere, although these concepts are logically independent, there is an epistemological link between these concepts because the "idea that there are no limits to development, that there are no insoluble problems or sheer messes, is often used to defend or justify the position that there are no limits to growth" (Lyons et al., 1995, 58). The limits to growth question is important for orthodox economics as Beckerman observes:

> some commentators have argued that, although the price mechanism may be a fairly efficient mechanism (subject to some well-known qualifications) for optimally allocating resources among alternative uses, it cannot handle the problem of achieving the optimal *scale* of total output. This would not matter if there were no environmental limits to the total scale of world output (Beckerman, 1995, p. 142).

If there are limits to growth because of "ecological scarcity" (Ophuls & Boyan, 1992) orthodox economics is faced with the problem of deciding the optimal scale of total output. Further, as McLaughlin (1993) has argued, economic growth is intrinsic to capitalism (McLaughlin, 1993, p. 42). Contrary to Daly and Cobb (1989) who support a green-capitalism with a steady state economy, capitalism is a growth system because the existence of debt forces a quest for profit. Debt is usually a function of the private ownership of financial capital by banks and other financial institutions because money is created as a debt to the banking system (Hotson, 1993). To create the sort of steady state society which Daly and Cobb support would require quite substantial changes to the financial sector of capitalism, which, as far as we are aware, they do not discuss.

More importantly, capitalism's rational economic man is a utility-maximizer and profit-maximizer who invariably regards nature as private property, a resource and a commodity. Any economic system which has as its basis the selfish pursuit of satisfaction and profit, which celebrates greed and usury as good, will at the very least have an environmental and conservation problem. If human wants are insatiable, as neoclassical economics supposes them to be, then if such wants are to be satisfied, the environment must pay the price. Garrett Hardin's "tragedy of the commons" thought-experiment well shows that individual rational economic men, selfishly pursuing their own self-interest, can produce collective environmental disaster (Hardin, 1994). In this context it is informative to recall Paul Ehrlich's conversation with a Japanese journalist (Meadows et al, 1992, pp. 187–8). Ehrlich expressed his view that the Japanese whaling industry would exterminate the source of its wealth, whales. The journalist said:

> You are thinking of the whaling industry as an organization that is interested in maintaining whales; actually it is better viewed as a huge quantity of [financial] capital attempting to earn the highest possible return. If it can exterminate whales in ten years and make a 15% profit, but it could only make 10% with a sustainable harvest, then it will exterminate them in ten years. After that, the money will be moved to exterminating some other resource (Meadows et al., 1992, 187–8).

Richard Douthwaite in *The Growth Illusion* has defended the thesis that capitalism is necessarily a growth-based system in more detail than is possible here (Douthwaite, 1992).

Limitationists believe that there are limits to growth; *cornucopians* dispute this and believe in the possibility and desirability of unending economic growth on Earth. Julian L. Simon, professor of business and management at the University of Maryland, and a leading critic of the limits to growth position, has expressed the cornucopian position in these words:

> Technology exists now to produce in virtually inexhaustible quantities just about all the products made by nature—foodstuffs, oil, even pearls and diamonds . . . We have in our hands now—actually in our libraries—the technology to feed, clothe and supply energy to an ever-growing population for the next 7 billion years [sic] . . . Even if no new knowledge were ever gained . . . we would be able to go on increasing our population forever . . . (quoted from Bartlett, 1996, p. 1).

Simon has developed this position in a number of works including *The Ultimate Resource* (Simon, 1981), *Population Matters* (Simon, 1990), *The Resourceful Earth* (Simon & Kahn (Eds.), 1984) and *The State of Humanity* (Simon (Ed.), 1995; Myers & Simon, 1994). Recently he has been joined by a number of others constituting a "green backlash" (Lewis, 1992; Ray &

Guzzo, 1993; Bailey, 1993, ed., 1995; Kaufman, 1994; Maley, 1994; Rubin 1994; Avery, 1995; Beckerman, 1995; Easterbrook, 1995; North, 1995; Wildavsky, 1995). We obviously cannot outline here in detail the cornucopian critique of limitationism and environmentalism but we can give a concise account of the general thrust of the critique.

First, the cornucopians all note that environmentalists have made many failed predictions. In particular they all mention Ehrlich's lost bet with Simon about the price rises of a set of metals, as well as Ehrlich's failed predictions of doom. However the cornucopians, including Simon have also made many failed predictions. Indeed, Beckerman admits that "in the last decade or so, all short-run economic predictions have been ludicrously wrong" (Beckerman, 1995, p. 88). Thus it is not unfair to leave this objection and pass on to more substantial arguments.

Richard North believes that scientific evidence "argues against the existence of a greenhouse crisis, against the notion that realistic policies could achieve any meaningful climatic impact, and against the claim that we must act now if we are to reduce the greenhouse threat" (North, 1995, p. 104). This sentiment is also shared by Bailey in *Eco-Scam* (1993) who points out that before the concerns with the enhanced greenhouse effect in the 1980s, the favored climatic apocalypse was thought to be an approaching ice-age (Bailey, 1993, pp. 79–87). In his introduction to his edited volume *The True State of the Planet* (Bailey, (Ed.), 1995), Bailey states that the Earth's atmosphere has actually cooled by 0.10 degrees Celcius since 1979 according to satellite-based atmospheric temperature measurements (another contributor states that the cooling factor is 0.13 degrees Celcius (Balling, 1995, p. 84)). For the cornucopians, global warming is a myth, and if it did occur its effects are likely to be economically beneficial. This view differs from the position of the Intergovernmental Panel on Climate Change (IPCC) which accepted in November, 1995, that greenhouse gas concentrations have risen as a result of human activities (Houghton et al., 1996). Average temperatures have risen by between 0.3°C and 0.6°C since the late 1800s. The IPCC predicts that temperatures will rise another 1° to 3°C by 2100. Sea levels will rise by an average of fifty centimeters and could reach ninety-five centimeters by 2100 (Smith et al., 1997). Further supporting evidence that human activities have affected global climate was supplied by Santer el al. (1996; Nicholls, 1996). The cornucopians would of course reject this.

Many biologists and ecologists are concerned about the decline of the world's biodiversity which has accelerated in this century (Wilson (Ed.), 1988; 1993). The cornucopians are not. According to S.R. Edwards "Documented animal extinctions peaked in the 1930s, and the number of extinctions have been declining since then" (Edwards, 1995, p. 212). This is inconsistent with the United Nations *Global Biodiversity Assessment* which estimates that the total number of species at risk could be as high as 30,000 (Smith et al., 1997, p. 4). Cornucopians again counter this figure by emphasizing the uncertainty of the estimate (Simon & Wildavsky, 1995). Further, they are free to respond to this problem as Beckerman does with respect to the human appropriation of the photosynthetic products: "So what?" Less photosynthesis means less vegetation, but this only reflects "a fall in the 'demand' for it from vegetation" (Beckerman, 1995, p. 52). Photosynthetic products not used by humans are simply wasted according to Beckerman. Man is not a part of nature.

Many environmentalists have also expressed concerns about the sustainability of modern industrial agriculture, arguing that even given its merits, it is often environmentally destructive with a massive social impact in the third world, destabilizing rural society and producing urban slums (Altieri et al., 1987; Strange, 1988; Body, 1991; Cherfas, 1992; Clunies-Ross & Hildyard, 1992; Goldsmith, 1994). Avery (1995) and Fumento (1993) reject these claims and celebrate the virtues of dioxin, pesticides, agricultural chemicals, large-scale agri-business and plastics. Their critique is a familiar one: emphasize the uncertainties of the scientific studies of the ill-effects of technology (after all, scientists disagree). Avery (1995, p. 21) quotes experts such as Piers Pinstrup-Anderson, Director of the International Food Policy Research Institute, Policy Research Unit of the Consultative Group on International Agricultural Research in Washington DC, as saying "that the long-term food picture looks promising because of rising crop yields." He said "We're not running out of [farming] resources" (Avery, 1995, p. 21). However we have more recent press releases by Pinstrup-Anderson where he expresses the view that severe water shortages could emerge in one in every five countries in the twenty-first century resulting in hunger that could produce a global refugee crisis (Smith et al., 1997, p. 3). We have traded expert-blows with the cornucopians in this fashion in our book *Healing a Wounded World* (Smith et al., 1997).[1]

Finally, the cornucopians believe, in North's words, that the "experiment in free trade and market-driven economies is the only game in town" (North, 1995, p. 287). They generally advocate open-borders, the free flow of immigration and they stand to a man against national self-reliance:

> The 1980s and 1990s, so far, have developed a consensus that capitalism must be left to operate with as little, and as carefully targeted, political interference as possible. . . . the political support for free trade and market economies is now so great that it

> has marginalised all left-wing thinking, including green-tinged left-wing thought (North, 1995, 254).

Free trade and market-driven economies will, in the cornucopian's opinion, produce an age of "increasing and unprecedented natural resource abundance" (Moore, 1995, p. 110). Stephen Moore argues that the very idea of finite physical resources, accepted by geologists, is becoming outmoded because of technological developments, fuelled by the free market system. "Natural resources" have value only when humanity invents a use for them" (Moore, 1995, p. 110). Moore follows Simon in arguing that for the past 100 years, almost every natural resource has declined in price and this fall in price indicates less scarcity. Hence the quantity is increasing. Natural resources are three times less expensive than they were fifty years ago (Moore, 1995, p. 111). The free market, by the feed-back mechanisms of supply and demand, delivers technological improvements which chase away the wolves of ecological scarcity:

> . . . the price of a natural resource today not only equilibrates current supply and demand but the market's best estimate about the future levels of supply and demand. There is no law of nature that says that the market is always setting the right price. Speculators who bought oil futures in the early 1970s and then sold them in the late 1970s made a fortune. Speculators who bought oil futures in the 1980s lost fortunes. But the market price does have the virtue of incorporating all the best and most relevant information we have available (Moore, 1995, p. 119).

However it would seem to be the case, as a point of logic, than in the Panglossian world of the cornucopians, markets must not only incorporate the best information, they must incorporate perfect information and economic agents must be perfectly rational and fully knowledgable. Markets must be perfect. If markets were imperfect (which they are in the real world) (Boulding, 1980), the mechanical feedback link between price and technological development would be broken.[2] The cornucopian's theoretical case would be refuted. (Cornucopianism may still be empirically or contingently true, but there would be no theoretical *necessity* to the position.) (Bhaskar, 1978). We will argue below that the price mechanism cannot adequately price ecological capital. Hence in this context even a perfect neoclassical market is imperfect and capitalism even in principle cannot deal with ecological scarcity.

Before the industrial age the limits to growth position or *limitationism* was the uncontested ruling wisdom (Leiss, 1988; Durning, 1992). Classical thought was sensitive to the existence of limits as was classical political economy. John Stuart Mill observed in his *Principles of Political Economy* (1848) that the increase in wealth is not limitless and that all progress in wealth-accumulation is a postponement of the stationary state (Mill, 1909, pp. 746–51). The idea of limits was lost in the marginalist revolution in economics, surviving only in the law of diminishing returns (as extra units of a factor of production are used, with all of the others held constant, the output generated by each extra unit will tend to fall). Even in this form, limitationism poses problems for cornucopianism as Giarini and Loubergé have shown in their application of the law of diminishing returns to technology (which is afterall, a factor of production) (Giarini & Loubergé, 1978). Economics' first major confrontation with limitationism in its thermodynamic form came with the work of Georgescu-Roegen (1966, 1971, p. 1976). A very extensive debate has followed about the relevance of thermodynamics, primarily of the second law of thermodynamics or the entropy law, to economics (Burness et al., 1980; Ayres & Nair, 1984; Burness & Cummings, 1986; Daly, 1986; 1992; Norgaard, 1985; Lee, 1989; Hardin, 1991; Ayres, 1993; McMichael, 1993; Ophuls & Boyan, 1992; Jaeger, 1995). In this debate we have seen Khalil (1990; 1991) deny that living beings are subject to the entropy law (Lozada, 1991) and Young (1991; 1994) deny that the entropy law is relevant to the economics of natural resource scarcity because the Earth is not a closed system with respect to energy (Daly, 1992). The radical ecologist Edward Goldsmith (1981a; b; 1992) also rejects the idea that the entropy law applies to living systems. He takes the "open systems" argument to its logical conclusion, rejecting the idea that the universe itself is a closed system (Goldsmith, 1992; 390). If this is correct, then the second law of thermodynamics should be abandoned by physicists. However as one of us found from a youthful advancement of this argument as a student (Smith, 1986), physicists are not prepared to abandon the entropy law. As we have argued elsewhere, the entropy law does apply to life and the economic process (Smith & Smith, 1996). It sets limits but it does not tell us what exactly these limits are. Such a position need not bother any hypothetical cornucopian with some knowledge of physics: "There is a limit to economic growth on earth. So what? We'll burn this planet out and then we'll find another one. If not, we'll die. Again, so what? In the long-run we are all dead."

The limits to growth position is best known through the 1972 book *The Limits to Growth* by D.H. Meadows et al. The thesis of this seldom read, but often refuted book, is that on the basis of a computer model of the world system, called World 3 (Meadows et al., 1974), given present trends of human population growth, industrial activity and resource depletion, the limits to growth will be reached sometime in the next 100 years. Wilfred Beckerman regarded this conclusion as "nonsense" that no-one should take seriously (Beckerman, 1972). The work was criticized by economists and the pro-growth lobby for its failed predictions of resource exhaustion, especially minerals. Nevertheless, the second model in *The Limits to Growth* which did not have resource depletion as a problem, led to disaster through pollution (Common, 1995) and certainly since 1972, a massive quantity of empirical evidence has accumulated which indicates that the source and sink functions of the global ecosystem are being stressed. Consider for example human biomass appropriation, global warming, the ozone shield depletion problem, land degradation and declining biodiversity (Giampietro et al., 1992; Goodland, 1992; Wackernagel & Rees, 1996). In *Beyond the Limits* (Meadows et al, 1992) the same World 3 model is used with minor updating. *Beyond the Limits* advances the overshoot thesis (Catton, 1982) that "many resource and pollution flows had grown beyond their sustainable limits" (Meadows et al., 1992, xiv). While they believe that the transition to a sustainable society is still possible, "Without significant reductions in material and energy flows, there will be in the coming decades an uncontrolled decline in per capital food output, energy use and industrial production" (Meadows et al., 1992, p. xvi). The authors recognize that World 3 has many nonlinear causal relationships and complex feedback structures (Meadows et al., 1992, p. 106). There are uncertainties enough in present climatic computer models analyzing the enhanced greenhouse effect and such uncertainties will be magnified by considering the entire world system. As William Nordhaus correctly observes (Nordhaus, 1992) the robustness of the longterm predictions of World 3 must remain under a dark cloud of uncertainty because of the complexity of the underlying nonlinear systems. However many economic policy decisions which significantly affect our lives are made on computer models which are based on demonstrably false propositions. The ORANI model of the Australian economy, used by both the Federal Government and the Industry Commission, is a static general equilibrium model which assumes that there is full employment, perfect competition and no financial sector (Toohey, 1994, pp. 175–6). Consequently if we are to follow the recommendations of the cornucopians, to suspend judgement on the predictions of models such as World 3, let us also abandon all existing computer models of national economies and the global economic system.

Beyond the Limits does not claim to make exact predictions, because it cannot. Rather it is concerned with broad patterns as the population approaches its carrying capacity—whether it grows, stabilizes, oscillates or declines. Continuous growth requires that physical limits are far off or physical limits grow exponentially. Sigmoid growth, an s-shaped approach to equilibrium, occurs if signals from the physical limits to the expanding economy are instant, accurate and immediately responded to without external limits forcing it. Overshoot and oscillation occurs if signals and responses are delayed and limits are unerodable or able to recover quickly from overshoot. Overshoot and collapse operates if signals and responses are delayed and limits are erodable, irreversibly degrading when overshoot occurs (Meadows et al., 1992, p. 123). Meadows et al recognize that World 3 has a tendency to overshoot and collapse because of these assumptions built into it: (1) the exponential growth of populations and economies as a whole; (2) there exist physical limits to the source and sink capacities of environments; (3) signals from the biosystem to the economic system are often distorted and delayed; (4) "[the] system's limits are not only finite, but erodable when they are overstressed or overused" (Meadows et al., 1992, pp. 139–40). These assumptions are in our opinion as correct as propositions in this field can be. Sigmoid growth can be discounted because it rests on an empirically false assumption (Ayres & Nair, 1984, 71). This leaves a choice between a continuous growth scenario and the overshoot scenarios. The continuous growth scenario logically entails that all of the people living on Earth late next century would be able to consume energy at a rate equal to the present American average equivalent to 12 ton of coal per year (Trainer, 1995a, p. 3). This would require energy production to be *fourteen times* the present level. Under continuous growth, economies grow at an exponential rate. A 5% per annum growth rate of the world economy means that after 70 years 32 times as much output per annum would be occurring. The cornucopians claim that technology will save the day and allow this growth to occur. Substitutes will always be found for exhausted resources. However the cornucopians wish for us to ignore limitationist arguments about resource depletion and environmental destruction because of *uncertainty*. They claim that "technology will save the day" even though this is a necessarily uncertain claim. We cannot predict the future course of technological development (Popper, 1972)—for all we know, technology may destroy us (Leslie, 1996). Hence on cornucopian premises, we have no good reason to accept their rebuttal of this limitationist argument. Therefore the overshoot and collapse model stands.

The pessimistic predictions of *The Limits to Growth* are supported by many independent studies, based on alternative methodologies. Here space permits us to mention in passing only the primary documents which the interested and/or sceptical reader should consult. Let us consider fossil fuels, a resource which even though it is described as nonrenewable, some cornucopians believe is inexhaustible. As Rifkin and Howard note in *Entropy* (1980) the industrial world and the mechanistic metaphysical world-view on which it is based, arose from the exploitation of a fossil fuel, coal, after the overcutting of Europe's forests occurred. The modern world is now highly dependent upon oil, as both a fuel for the engine of global capitalism and for the production of many products such as plastics. Without oil-based products most high tech products in our homes and offices would not exist: they would be far too expensive. The miracle of plastic is that it allows injection molding and consequently quick and easy mass production of products. But fossil fuels are being depleted 100,000 times faster than they are being formed (Price, 1995, 310). In the case of oil, it is true that Middle East suppliers are facing a financial crisis because of the low price of oil, but this is essentially politically caused because the West wants to be less dependent upon Middle East suppliers. The world is in fact facing a looming global fossil fuel depletion crisis as Fleay (1995) describes:

> Oil production in the major producing regions of the world is reaching its peak and beginning a decline. A fifty year transition period began in the USA in 1970. The former Soviet Union's (FSU's) oil production peaked in 1989 and has suffered a rapid decline since. The remainder of the producing regions outside the Arabian Gulf are expected to peak by the year 2005. The Arabian Gulf region, with two thirds of world oil reserves, is likely to peak last in about 2020. Production of oil in the world as a whole is likely to peak some ten years earlier (Fleay, 1995, p. 1).

The development of unexplored regions, the Arctic ocean or offshore in deep water on the continental slopes, will be very expensive. Oil production in the United States peaked over 20 years ago and over 80% of ultimate US oil production has occurred. The energy cost per foot of drilling and extracting has been increasing steadily since 1945 and the energy cost of finding and extracting oil will equal the energy content of the oil found around the year 2005 (Fleay, 1995, p. 17). US domestic oil supplies will be effectively depleted by the year 2020 (Hall, et al., 1986; Gever et al., 1991; Kraushaar & Ristinen, 1993; Phipps, 1993; Fleay, 1995, 15–16; Bronner, 1996). Consequently the United States will cease to be a food exporter between 2007 and 2025 (Gever et al., 1991). World oil discovery rates have peaked and are declining. The leader energy research organization, Petroconsultants, issued an estimate in 1995 of the world's remaining oil supplies. They found that world oil supply will peak by the year 2000 and by 2025 will be depleted to one third of the present volume. The oil era will be over long before 2050. Without a cheap renewable substitute, the industrial era will be over.

Certainly the "Asian miracle" will be over because this has been dependent upon oil. In 1993 China became an importer of oil. There may be significant reserves in the Tarim Basin in north-west China, but the remoteness of this area makes it a high-risk development. Japan, of course, is a net importer of virtually all of its energy. Even Indonesia is expected to become an oil-importer in the 1990s. The Asian miracle depends upon cheap transport and this in turn depends upon oil. In general, the end of the oil age will destroy the dreams of the internationalists and global capitalists of creating a global consumer supermarket. The "one world" dream and all its pernicious ideological trappings will end (Lyons et al., 1995). However we disagree with Fleay (1995) and other environmentalists (Trainer, 1996) who see a new age of green values drawing with a new nonmechanistic and nonreductionistic science, a reenchantment of nature, an end of elitism and an ecologically sustainable energy-efficient social order. These may be noble sentiments, but these Enlightenment values are equally as threatened by ecological scarcity (Smith et al., 1997). We will have more to say on this issue later.

The cornucopians are confident that renewable energy resources will sustain technoindustrial society at present growth rates and beyond. The burden of proof must be firmly upon the shoulders of the cornucopians here. Trainer (1995b) has argued that although renewable energy resources will be the key energy sources of a conserver society, they cannot sustain our present affluent society and the super-affluent society which cornucopians envisage for the future. Chandrasekar (1994) has shown that there is little evidence that the US government and industry are making the necessary transformation toward renewable energy-based technology. The US Office of Technology Assessment still thinks in terms of increased supplies of fossil fuels, and of an "abundant energy machine" (Chandrasekar, 1994). Left to market forces, rather than social and environmental decision-making, the run to home base is being left a little late.

Technology will save us, the cornucopian will say. High tech fixes such as nuclear fusion may come in the nick of time. Developments are proceeding. The Princeton Plasma Physics Laboratory produced five million watts of energy through nuclear fusion in December 1994. This was very expensive electricity to say the least. Nevertheless, the cornucopians believe that a combination of nuclear fusion, solar, hydrogen and other renewable energy sources, all used in union and systematically will solve humanity's energy problems. But this is again mere assertion and with assertion any problem can be solved. Our hard-nosed position is that until we have these technologies in hand and they can be demonstrated to solve our resource problems, cornucopianism is wrong and limitationism is right by default. The methodological scepticism of the scientific method favors limitationism over cornucopianism.

In the next section we will examine the cornucopian, and orthodox economic belief that neoclassical economics constitutes an adequate environmental economics. We will argue that this is not so.

THE LIMITS OF ECONOMICS: ENVIRONMENTAL AND FREE MARKET

Environmental economics is the application of the principles of neoclassical economics to the environment and environmental resources. Early work in this tradition (Isle, 1925; Hotelling, 1931) studied the optimal rate of use of exhaustible resources. By way of illustration, an important claim in this field is Hotelling's rule, that an exhaustible resource would be depleted at a rate consistent with the rate of price increases being equal to the discount rate (Hotelling, 1931, pp. 140–1). In other words compare the revenue gained on the interest of the difference between the price and the cost of the marginal quantity of the resource with the expected increase in net revenue if the resource is not extracted but conserved (Pearce & Turner, 1990, p. 272). Resource conservation decisions are to be made on the grounds of economic profitability (Eckersley, 1992). Free market environmentalism, a dominant subbranch of environmental economics, maintains that environmental externalities such as resource depletion and pollution do not arise from the operation of the free market system but rather from the lack of ownership of environmental assets. Free market economics can be seen at its best in the so-called *Coase theorem* (Coase, 1960) that states that independently of who is granted property rights, bargaining in a free market situation will result in allocation efficiency. Property rights can be assigned to the victim of the pollution just as easily as the generator of the pollution.

The Coase theorem is also said to give a presumption in favor of free trade (Hillman, 1989, p. 4–5). The argument proceeds by letting the gainers and losers from free trade determine a nation's trade policy. The gainers naturally enough choose free trade. But the losers from free trade will also choose free trade because free trade allegedly offers superior consumption possibilities and so given their discretion to determine trade policy they will act to maximize their gains from free trade. We reject this argument because it is based on magical premises because the losers from free trade, bankrupt businesses and displaced workers are not in a position to determine anything. The so-called theorem, which Coase never rigorously mathematically proved (Hanly, 1992, p. 79) amounts only to the claim that if the losers were to be in the position of gainers, they would favor free trade. If one is free to assume any state of the world then anything can be proved. For example the neoclassical economist asserts that free trade delivers superior consumption possibilities because it delivers lots of cheap goods, made in Asia, for us to consume. However economic nationalists will not define "superior consumption possibilities" in that way. A worker in the footwear industry with little possibility of finding another job does not have his utility maximized if he loses his job because of cheap imports. Seeing the negative social costs of free trade, in a situation where he is given the chance to determine trade policy, he may well choose protection. The point here is that neoclassical economics cannot criticize tastes or motives. If the Coasian agent chooses protection because he hates say the Chinese, then if that action maximizes expected utility, it is correct. Sagoff (1994, pp. 285–8) has argued that markets cannot fail to rationally allocate and price environmental resources as long as individuals are assumed to be economically rational utility maximizers: "markets will always allocate resources to those who are willing to pay the most for them and, therefore, that the price of goods will always reflect the full social costs, including the bargaining costs, of providing them" (Sagoff, 1994, p. 285). Utility maximizers always maximize utility; in the world of neoclassical economics whatever is, must be efficient, so every market (despite appearances) must be perfectly efficient given resource limits. So social and private costs must coincide because the "price is always right" (Sagoff, 1994, 288). But we know that this is not the case, so Sagoff's argument constitutes a *reductio ad absurdum* of neoclassical economics. Market failure is impossible and market failure *is* possible.

The general idea behind the Coase theorem is that policy decisions should be made on the basis of considerations of optimal resource allocation rather than on legal/moral grounds of entitlement. Although this theorem is often cited in defense of capitalism and private property, optimality conditions could favor a wide range of socialization policies if governments were highly efficient and private firms were not, as a matter of fact. A form of ecological socialism or even the conserver society of the greens could be argued to be more efficient in the use of scarce resources than global capitalism (Trainer, 1995a) primarily because it advocates conservation, cutting back on needless consumption, the minimalization of transport costs by local self-reliance and so on. So the Coase theorem could be put to use to undermine free market environmentalism. But there are other problems with the theorem. Although it assumes no transaction costs, when there are many polluters and many victims, the costs of bargaining cannot be ignored (Cropper & Oates, 1992, p. 680). The Coase theorem also ignores income effects that would occur when property rights are altered (Common, 1995; Jaeger, 1995, p. 48). Worse, an allocatively efficient solution to an environmental problem is one which maximizes the expected utility of the parties at the dispute through bargaining. This does not necessarily correspond to an ecologically sustainable solution and it does not mean that ecological disasters will not occur because of the actions (Gowdy & McDaniel, 1995, pp. 186–7).

The core of environmental economics is economically valuing the environment (Anderson & Leal, 1991; Pearce et al., 1990; Pearce, 1991; 1993; 1995). According to this discipline, any decision implies a monetary valuation. To build a motorway through a site of natural beauty implies that the natural beauty was not worth the tunnel construction (Barde & Pearce (Eds.), 1991). The alternative to simply not costing environmental assets is *cost-benefit* analysis (CBA), comparing the costs and benefits of the development. The concept of the Net Present Value (NPV) is defined as follows:

$$NPV = \left\{(B_0 - C_0) + \frac{(B_1 - C_1)}{(1 + r)} + \ldots + \frac{(B_T - C_T)}{(1 + r)^t}\right\}$$

where r is the interest, t is time periods and T is the lifetime of the project. A project should go ahead if NPV is positive or zero. *Discounting* involves dividing a sum at a period t by $(1 + r)^t$ to derive the present value. As t increases $(1 + r)^t$ increases, hence costs and benefits are discounted more, r being the discount rate. People presumably regard costs and benefits that are further in the future as less important than present costs and benefits, so future costs and benefits must be discounted. CBA is advanced to achieve intertemporal efficiency. The objection that discounting is unfair to future generations is dismissed by economists on the grounds that CBA is about intertemporal efficiency, not about achieving intertemporal equity (Price, 1993; Broome, 1994). Clark (1991, p. 325) maintains that discounting necessarily reduces the concern for the future as does Gowdy and McDaniel (1995, p. 186). Clark argues that with normal rates of return an investment of 10%, an optimal strategy for whalers, for example, will be to wipe out the whales and invest elsewhere (we made the same point earlier). Clark believes that many cases of the "tragedy of the commons" can be seen alternatively as corporate strategies arising from discounting.

The argument that discounting of environmental assets is justified because of the time preference of consumers—that consumers are impatient and would prefer to consume now rather than later—has also been questioned (Gowdy & McDaniel, 1995). The environmental crisis indicates that people are quite willing to forego present utility maximization to the point of even laying down their lives to preserve the planet. And what is wrong with that? It seems a much more noble thing to do than to lay down one's life for the utility satisfaction of international capitalists as millions of people have done in this century. Recognizing that our economic system will lead to a badly degraded world some people may maintain that even though they do not exist, the welfare of future generations is of *greater* value than our own.

Another argument for discounting is based on the marginal productivity of capital: a dollar's worth of resources used now will generate more than a dollar's worth of resources preserved for the future; hence "an entrepreneur would be willing to pay more than a [dollar] to acquire a [dollar] worth of such resources now" (Pearce et al, 1990, p. 24). The comparison of environment to capital so that the productivity of capital justifies discounting seems to assume that $100 invested today can grow at a compound rate of 10%, so $100 "worth of environment" will also grow at a compound rate. The comparison is absurd (Jacobs, 1991).

For cost-benefit analysis to work, all of the economic costs and benefits must be identified and prices must be assigned even if they are only "shadow prices"—being measures of true market prices when actual market prices either do not exist or are distorted by market imperfections. Central to CBA is the idea that we are assigning consumer's preferences to the various costs and benefits and central to all of this is the *total value framework*, that economic goods and the environment can be thought of in terms of a single value measure so that the total values associated with different courses of actions can be summed and compared. On this basis various valuation techniques have been devised to cost the environment (Izmir, 1995) which are summarized as follows:

Techniques Used to Value the Environment-Survey Techniques

1. Contingent valuation method: a survey of peoples' willingness to pay to preserve or willingness to accept compensation for destruction of an environmental good.

2. Delphi Technique: uses opinion of a panel of experts to value an environmental good.

Surrogate Market Techniques

1. Hedonistic price method: the differences in prices of market goods used to value environmental goods.
2. Travel cost method: travel cost used value environmental goods.

Market-Based Techniques

1. Preventative expenditure—expenditure is examined, to offset a fall in environmental quality.
2. Replacement/repair cost—examines costs incurred as a result of environmental decline.
3. Dose-response approach—examines changes in the quantity of outputs arising from quality-decline of environmental good.
4. Human capital approach—examines earnings and cost of illnesses to value environmental goods.
5. Opportunity cost approach—examines the value of other uses of an environmental good (Ismir, 1995, p. 306).

Now an objection that has been made to the very idea of costing the environment is that people may refuse to put monetary values on environmental amenities: they may refuse to see the matter in economic terms at all. If they place an infinite value on environmental preservation, in a contingent valuation survey, then in the resulting CBA, costs will always exceed benefits (providing benefits are not infinite) (Hamilton, 1994, pp. 79–80). If economists ignore such infinite value assessments, they are being inconsistent, violating their own principle of consumer sovereignty. Pearce et al (1990) object to the idea of an infinite price for environmental resources because nobody can or would pay an infinite price for such goods. Certainly nobody can, but that is not the point—the point being to value such assets. We are certain that many Earth First! people if allowed to create credit out of nothing as the banking system does (without reserves or backing which banks have in part, the fractional reserve ratio), would write out a check for an infinite number of dollars. Pearce et al (1990) also object to the idea that one cannot place a monetary value on environmental assets, as we do so with human life all the time in the building industry. Perhaps this is so but it does not show that such monetary valuations are correct or that money is an adequate measuring rod.

The total value framework only has initial plausibility because CBA is usually only applied on a project by project basis. However given the environmental crisis and the likelihood that economic growth is already "beyond the limits," this project-by-project method could lead us to destruction by a sorites style argument as we approach our doom, project by project. The problem here is that "the ecological component of the system is not observable through the price mechanism, and so is not controllable through that mechanism either" (Perrings, 1995, p. 62). Our knowledge of the complex dynamic nonlinear systems in ecosystems is very limited (Botkin, 1990; Peters, 1991; Harte, 1995) and to suppose that we can break up the environment into atoms which can be valued and assessed by market forces (Edwards, 1987) is absurd (Norgaard, 1985; Norton, 1987; Sagoff, 1988; Brennan, 1992; Gowdy & Olsen, 1994). It indicates a major flaw in the environmental economics approach (Gowdy & Olsen, 1994). True, choices must be made and environmental assets must be diminished for our lives to continue at all. But in a world of tightening limits it does not follow that we can compare costs and benefits. Many of the things which we take to be benefits—such as economic growth itself—may turn out to be costs. In a world of limits we will often be faced with choosing the least *worse* option, not necessarily the best which may be inaccessible. As environmental economics is firmly based on neoclassical economics (cost-benefit analysis for example is a special case of utilitarianism) (Edwards, 1987, p. 74) having rejected neoclassical economics (Smith et al, 1997), we are free to reject environmental economics.

Before concluding this section, one further issue shall concern us. There is an argument discussed by Beckerman (1995, pp. 144–6), first advanced by Parfit (1984), which seems to indicate that we should not be concerned with environmental depletion in any case, so all of the above arguments are irrelevant. The argument is based on the *identity problem*. Parfit's scenario involves adoption of an orthodox economic growth policy known as the "depletion policy." Because of this policy, the environment and the standard of living of the people that will be alive in a century's time would not be as good if "the conservation policy" was adopted. Now the depletion policy will mean that the people alive in 100 years time will not be the same as those that would have been alive under the conservation policy so how can those people alive claim to be harmed by depletion. They will find life worth living—so what do they have to complain about? Let us grant Parfit's metaphysics: even a slight change in the world could alter the "identity" of the sperm which reached the egg etc. and the time of conception. The moral theory underlying this view is known as identity-specific or person-affecting morality, namely that wrongs require someone to be wronged and if no persons are harmed, then there is no harm done. Parfit's argument seems to lead to the view that future generations cannot be harmed by adoption of a depletion policy and taken to its logical conclusion the argument would seem to undermine all conservation policies.

But this is not so, for by a twist of logic, Parfit's argument can be turned on its head. Suppose that a conservation policy was adopted. Then this would lower the standard of living of people existing today in utilitarian terms, but they would still have meaningful lives. By changing their mode of living by adopting conservation policies and changing their belief systems by adopting environmentalism, a change in tastes and economic preferences will occur. This in turn will give rise to a new demand curve for each consumer. So, after all, we cannot criticize the adoption of conservation policies because they will diminish the welfare or utility satisfaction of people, because welfare and utility satisfaction above a certain biological minimum are dependent upon preferences and preferences are ultimately dependent upon a subject's beliefs (Cowen, 1993). As a result of the adoption of a conservation policy, a different set of people come into being in 100 years time and they are glad to be existing because of conservation policies. Further, we can take the depletion problem as showing the limits of identity-specific moral theories. We can say that depletion and conservation will change the identity of future people, but irrespective of their identities it is still preferable that they live in a clean, biologically rich world, than having lives barely worth living on a wounded and degraded planet.

In this section we have argued against the idea that orthodox neoclassical economics constitutes an adequate environmental economics. We now turn to criticize directly the cornucopian and technological optimist belief that technology will save mankind from the wages of ecological scarcity and we develop our pessimistic thesis that even if humanity does survive as a biological kind, technoindustrial civilization will not.

RAGNAROK: THE END OF THE WORLD

In ancient Norse mythology *Ragnarok* or *Ragnarökk* (*Ragnarökkr*, from *regin*, the gods + *rökkr*, twilight; German equivalent *Götterdämmerung*) was the final cataclysmic battle between the gods (the *Aesir*) and the forces of evil. Apocalyptic scenarios such as this one are common in the great world religions. Usually, as in Judeo-Christianity, the forces of good triumph without even raising a sweat because the good guys are infinitely powered while the bad guys are not. Victory was guaranteed before the battle ever took place, by logical necessity. Norse mythology (what is now called *Asatru* or *Odinism*—consult the World Wide Web) has no such rosy picture of reality. The forces of good will be defeated and the world destroyed. Neither good nor evil shall triumph but both will destroy each other. Their destruction though will enable a new world to be born, growing from the decaying ruins of the old. Now as the reader is no doubt aware, our book shop shelves sag with the weight of popular science books telling us that quantum mechanics and general relativity confirm the metaphysics of various Oriental philosophies. This may be so, although none of these authors tell us what happens when quantum mechanics and general relativity theory are falsified and replaced, as scientific theories of this nature invariably are. But could it not be argued that Norse mythology also has its merits, as an ecological eschatology? Many works of radical environmentalism would seem to fit such a pattern. Joel Jay Kassiola in *The Death of Industrial Civilization* (1990) believes that industrial civilization will collapse but this will not mean the end of the world as a new "transindustrial society" will arise like a phoenix from the ashes and soot of the old world. Ted Trainer (1995a) believes that the affluent society is not sustainable and that for the world's population to be sustained, a movement must be made now to a conserver society which is a much less affluent, simpler, more cooperative and self-sufficient way of living. It is an implication of this view that if the West does not move towards this, a global battle for resources will occur. This shredding of the world will mean that a violent collapse of technoindustrial society will occur with ecological necessity forcing us to adopt a conserver lifestyle. David Price (1995) sees ecological scarcity leading to a collapse of civilization, with starvation, social chaos and disease culling the human population. He describes the world of survivors:

> These people might get by, for a while, by picking through the wreckage of civilization, but soon they would have to lead simpler lives, like the hunters and subsistence farmers of the past. They would not have the resources to build great public works or carry forward scientific inquiry. They could not let individuals remain unproductive as they wrote novels or composed symphonies. After a few generations, they might come to believe that the rubble amid which they live is the remains of cities built by gods.
>
> Or it may prove impossible for even a few survivors to subsist on the meagre resources left in civilization's wake. The children of the highly technological society into which more and more of the world's peoples are being drawn will not know how to support themselves by hunting and gathering or by sim-

> ple agriculture. In addition, the wealth of wild animals that once sustain hunting societies will be gone, and topsoil that has been spoiled by tractors will yield poorly to the hoe. A species that has come to depend on complex technologies to mediate its relationship with the environment may not long survive their loss (Price, 1995, p. 316).

Richard Duncan (1993), arguing on the basis of White's Law (that civilizations advance, stagnate or decline as the energy-use per person per annum, increases, levels or decreases), concludes that the life-expectancy of industrial civilization is less than 100 years. This seems to be the general conclusion reached by limitationist thought. Following Norse mythology we will call this the *Ragnarok thesis*. We will defend this thesis here and conclude with some speculations about the fate of civilization.

The Ragnarok thesis is, obviously enough, denied by the cornucopians and technological optimists. A vast and expanding literature exists discussing or celebrating high technology, postmodern cyberculture and cyberpunk, our cyborgic disappearance into digital or virtual reality, the blurring of the boundary between human and non-human and the death of nature (Hardison, 1990; McKibben, 1990; Callicot, 1992; Maszlish, 1993; Berry, 1995; Dery, 1995; Gray, 1995; Kelly, 1995; Anderson, 1996; Sirius, 1996). Let us consider briefly one example of this literature. Adrian Berry's *The Next 500 Years* (1995) follows the technological optimism of Julian Simon, who is quoted with approval. Berry maintains that unless a cosmic catastrophe occurs "there seems to be every reason to believe that this progress will continue indefinitely" (Berry, 1995, p. 22). Environmental problems "tend to be exaggerated to the point of hysteria" (Berry, 1995, p. 22). In Berry's opinion there is no sign of the enhanced greenhouse effect occurring and little "substance" to ozone depletion (Berry, 1995, p. 53). He regards the limits to growth tradition as deeply flawed. He looks forward to the colonization of Mars and the downloading of human personalities onto computer disc. However in a fascinating chapter on the next ice age (Berry, 1995, pp. 55–62), Berry's technological optimism begins to break down. Interglacial periods have lasted only 8–12,000 years during the Pleistocene period. Ninety percent of the last 1.8 million years have been ice age periods. Berry admits that a civilization as large and advanced as the present one will find it difficult to survive and also that the next ice age is long overdue. He proposes that there may be a collapse of today's "balmy" climate (a hypothesis which is still logically consistent with the existence of an enhanced greenhouse effect), taking place over the next twenty years marking the start of the next ice age. We have only 500 years to construct the technology to prevent this: "When the ice sheets advance once more from the polar regions, civilization as we know it in the temperate zones will become impossible. Thousands of millions of people will lose their homes, their livelihoods and probably their lives as well" (Berry, 1995, p. 58). The technology needed to prevent this involves placing giant mirrors in orbit above the Earth to increase the amount of sunlight reaching the planet. He hopes that in a century's time the technology to do this will be available. Whether this technology can be developed in time, and whether it would be sufficient to prevent another ice age is anybody's guess.

Berry outlines a number of concerns about high tech society and computerization. The creation of a post-biological world is not without its problems, at least for humans. He quotes Kevin Warwick, professor of cybernetics at Reading University who states in a nutshell the ultimate ramifications of the cybernetic revolution and of the creation of thinking machines:

> The creatures we create might not like the human race as much as we do. The obvious danger is that we might not be around much longer or we might lead just a slave-type existence. People who say it will never happen are not being realistic. If something is more intelligent than us, we will not be top dogs on Earth anymore. This is the logical conclusion of current work in the field of robotics and artificial intelligence. It is frightening. I don't like to think about it. But if machines can be made as intelligent as humans, then that's really it for the human race (Berry, 1995, p. 101).

Berry goes on to outline ways that artificial intelligence may differ from human intelligence that may lead to our destruction, primarily based on the fact that artificial intelligence constitutes an alien form of reason. He also recognizes that extraterrestrials, if they exist, need not necessarily be friendly (Berry, 1995, p. 237). This point is a timely one given the present excitement (and scepticism) in the scientific world about NASA's announcement in August, 1996, that meteorite ALH 84001, collected in 1984 from Antarctica, contains biological imprints of microfossil forms that constitute evidence for primitive life on early Mars. Let us develop Berry's point. Suppose that this is actually so. If it is the case that life has arisen on two planets that we know of, and given that planets are common around nearby stars, then life should be common in our galaxy and probably in others. Suppose as well that there is nothing in principle to stop life getting past the primitive level and nothing to stop an intelligence capable of using technology evolving. Now on technological optimist premises, there is nothing as well to prevent the development of technologically sophisticated intelligence at least equal to humans throughout the universe. So where are they? If they can communicate with us, why have they not done so? (Davies, 1995; Zuckerman & Hart (Eds.), 1995). None of the hypotheses advanced to account for the absence of communication or contact support technological optimism and the internationalist ideology associated with it. Hypotheses such as that advanced civilizations always self-destruct or that they do not have the technology to be able to communicate with us or engage in space travel, conflict with technological optimism. If the extraterrestrials have transcended biology and are now super-computers, they may have no interest in carbon life forms. Or they may be living beings but choose instead to keep to their own race. Either way such attitudes are highly politically incorrect and constitute cosmic racism. After all, the philosophical ideology (as we shall see below) of cornucopianism and technological optimism is cosmopolitanism: "we are all one universe, one people, who are all equal, and who all love each other." The very idea that extraterrestrials could be hostile, capable of cosmic race-hate and terrestrial genocide, was discounted by the SETI (search for extraterrestrial intelligence program). They need only have observed contemporary human societies to see how questionable this assumption actually is.

The radical environmentalist or deep green critique of technological optimism is that technology is out of control and that technological advances are responsible in large part for the environmental crisis. This view is promoted in the British journal *The Ecologist* and by others (for review cf) (Drengson, 1995). It is often associated with a nostalgia for preindustrial belief systems (so long as they are *not* Northern European) and ways of life that celebrate the moral superiority of the "noble savage" (Mander, 1991; Lewis, 1992). Ellul (1990) argues that technology is leading us to catastrophe and the bluff of technological discourse is lulling us into complacency. Indeed, technology rules our lives by a form of terrorism in Ellul's opinion, the "molding [of] the unconsciousness with no possibility of resistance" (Ellul, 1990, p. 384). Technology produces irreversible dependence and subjugation. For Ellul: (1) all technological progress has its price; (2) at each stage it raises more and greater problems than it solves; (3) its harmful effects are inseparable from its beneficial effects and (4) it has a great number of unforeseen effects. The deep ecologist Andrew McLaughlin (1993) also believes that science has provided a metaphysical justification for the domination of the natural world. Physics presents us with a world where nature is devoid of secondary qualities such as color and is lifeless and lacking in intrinsic meaning. Science, in McLaughlin's opinion, undercuts any "ontological basis for objection" to treating nature as an object (McLaughlin, 1993, p. 99) and this fits well with the needs of industrialism and global capitalist society (Heilbroner, 1985, p. 135; McKibben, 1990, p. 213; Merchant, 1990, p. 193). McLaughlin concludes: "Science now stands in religion's stead, functioning as the equivalent of the medieval Christian church" (McLaughlin, 1993, p. 100). Other deep ecologists share this concern (Devall & Sessions, 1985).

Brian Appleyard (1993), although critical of environmentalism, which he sees as a "religion of rejection" (Appleyard, 1993, p. 136), shorn of transcendental rationale and meaning, nevertheless shares with radical environmentalists and social critics a horror of modern science and technological culture. Science "has gone too far, . . . it is potentially out of control and . . . now threatens to throw our civilization out of balance" (Appleyard, 1993, p. xviii). Science in his opinion has denied our ultimate significance (he does not say what this actually is); it is "spiritually corrosive, burning away ancient authorities and traditions" (Appleyard, 1993, p. 9). Nor is science in Appleyard's opinion a process towards true knowledge; the history of science is "a sad [story], a long tale of decline and defeat, of a struggle to hold back the cruel pessimism of science" (Appleyard, 1993, p. 79). Appleyard sees modern liberal-democratic society as a creation of science and as a traditionalist he is critical of modernity and other values of the Enlightenment cherished by liberal-internationalism. He notes that "[p]eople live unliberal lives", they "prefer their families and friends to complete strangers" (Appleyard, 1993, p. 240) and in general we prefer our own kind to people of other races, ethnicities and nationalities: "Society may advocate liberal tolerance and open-mindedness, but nobody practices it . . . a complete personal acceptance of scientific-liberalism would reduce society to passive, bestial anarchy" (Appleyard, 1993, pp. 240–1). Scientific liberalism is a philosophy of "terminal decadence" in Appleyard's view because plurality and tolerance cannot provide an adequate basis of a coherent society. Appleyard favors an Aristotelian concept of the good, which is anti-pluralistic, anti-egalitarian and anti-tolerance (Appleyard, 1993, p. 249). If Appleyard's critique of scientific civilization is only partially correct, it still supplies a reason for believing that scientific and technological advances could have a socially destabilizing effect and at least do not always produce progress and social harmony.

Sir James Goldsmith in *The Trap* (1994) is also critical of key Enlightenment ideas, such as the "enthronement of scientific reason," "the project of a universal civilization" and the creation of a cosmopolitan culture. Enlightenmentism "produced extraordinary material innovation and economic growth. But it destroyed the diversity of cultures in which human beings have traditionally lived and in which their lives have found meaning" (Goldsmith, 1994, p. 184; cf also Lyons, 1979; Sylvan, 1985; Gare, 1993; 1995). The Enlightenment value of scientific and technological progress is rejected by the economist John Gowdy (1994) and also by an entire tradition of cognitive relativist postmodernists (Smith et al., 1997) and ecofeminists (Merchant, 1992). Since the time of Max Weber's critique of capitalism's rationalizing and intellectualizing tendencies which has led to a "disenchantment of the world" (Weber, 1958, p. 155) many social theorists have also opposed the rationalizing tendencies of modernity (Heilbronner, 1973; Smith, 1996). Again, if this neo-romantic and anti-modernist critique of technoindustrial society is even partially correct (it cannot be correct *in toto* because various aspects of the critique of modernity internally conflict) we would have powerful grounds for rejecting cornucopianism and technological optimism. We can only assess the strength of the anti-modernist critique by considering the strength of the argument of the critical response which has been made to this critique (Wolpert, 1993; Gross & Levitt, 1994; Kurtz & Madigan (Eds.), 1994; Kauffman, 1995; Allaby, 1996). In terms of pure analytic philosophy, we have argued elsewhere (Smith et al., 1997) that this modernist defense fails. Further, many of these works are not so much concerned with defending the rationality of science as the desirability of the new world order of liberal internationalism—global capitalism and open borders. Nationalism and tradition are identified as the enemies of Enlightened progress as is the Green movement (Bunge, 1994, p. 26). Allaby dismisses Malthus' work as "self-contradictory and wrong," "pseudo-science and prejudice" (Allaby, 1996, p. 165), it seems because Allaby does not like Malthus' anti-egalitarianism. Allaby formerly supported the limits to growth position in 1972, but now he has seen the light and recognized that he underestimated human ingenuity, "the only one resource that appears to be infinitely renewable and incapable of depletion" (Allaby, 1996, p. 178). He strongly defends nuclear power, an advanced technology which he sees to be based on a reliable and well understood science (Allaby, 1996).

A substantial contribution towards eschatological thought has been made by John Leslie in his recent book *The End of the World: The Science and Ethics of Human Extinction* (1996). The central thesis of the book is organized around the *doomsday argument*, first advanced by the cosmologist Brandon Carter (1983) (so much for the cornucopian claim that science supports a rosy view of the future) (Barrow & Tipler, 1988). The logic of the argument is subtle: humankind is unlikely to survive for a long time because if it did, we would be extraordinarily early in human history. Consequently "we ought to feel *some* reluctance to accept any theory which made us very exceptionally early among humans who would ever have been born. The sheer fact that such a theory made us very exceptionally early would at least strengthen any reasons we had for rejecting it" (Leslie, 1996, p. 3). How these reasons are strengthened depends upon the strength of competing reasons, such as humans surviving for centuries and colonizing the galaxy. Therefore the argument does not guarantee risk-estimates by itself: "It is an argument for *revising* the estimates which we generate when we consider various possible dangers" (Leslie, 1996, p. 3). The known risks discussed by Leslie include nuclear, biological and chemical warfare and terrorism; destruction of the ozone layer; a runaway greenhouse effect; pollution-overload; global disease; natural disasters such as massive volcanic eruptions producing a "volcanic" winter; asteroid and comet strike; an extreme ice age produced by passage through an interstellar cloud; the impact of a nearby supernova explosion; cosmic explosions caused by black hole evaporation or black hole or neutron star collisions and the chaotic breakdown of the Earth's ecosystems or of the solar system itself. Technological disasters discussed by Leslie include genetic engineering disasters; runaway nanotechnology disasters; the production of black holes or a new "Big Bang" in the laboratory; the production of an all-destroying phase transition in a high-energy physics experiment that destroys the universe and annihilation by extraterrestrials if they exist (they may be unintelligent but lethal space viruses) (Leslie, 1996, pp. 4–9). Leslie also considers threats associated with the breakdown of values and meaning, including Schopenhauerian pessimism, ethical relativism/nihilism and negative utilitarianism. Leslie concludes: "suppose that you suddenly notice all this. You should then be more inclined than before to forecast humankind's imminent extinction" (Leslie, 1996, p. 14).

Leslie's concern is with the extinction of the human race. He shows that the probability of this occurring is much higher than most people expect. We also have argued along similar lines (Smith et al., 1997). However the doomsday argument can be put to more modest uses where it yields more powerful results. Instead of considering the extinction of the human race consider the extinction of technoindustrial society or the Ragnarok thesis. If the cornucopians and technological optimists are right then we are exceptionally early members of technoindustrial society, for instance in the earliest 0.001% of people who will ever live in technoindustrial society. But we should have a great reluctance to believe this. First, on inductive grounds all other great civilizations have collapsed and perhaps all or any extraterrestrial civilizations have destroyed themselves. Why should ours be any different? Faced with the objection that our technological sophistication is unique and thereby does not put us at risk, we reply that our technological sophistication does put us at risk. As Taylor has observed, the high tech society is a highly vulnerable society:

> The country-dweller of 50 years ago could ride out a blizzard without help. The modern city-dweller depends on the continuance of power, transport, communication, sewerage, food import and refuse collection for his existence. A two-week interruption of a single public service would constitute a crisis; a four-week break in all of them would be a catastrophe (Taylor, 1970, p. 292).

Consider now the conditional probability of the collapse or destruction of technoindustrial civilization (A) given the present state of the world (E). Then the conditional probability of A given E can be written as:

$$\Pr(A \mid E) = \frac{\text{number of ways A and E can occur}}{\text{number of ways E can occur.}}$$

Now the number of ways E can occur is 1 as E is the present state of the world—it is just that which exists. Consequently Pr (A | E) increases as the number of ways A, the collapse of technoindustrial civilization, increases. Each of A_1, A_2, A_3, . . . A_n has a non-zero probability that it will alone destroy technoindustrial society. However all of A_1, A_2, . . . A_n can simultaneously occur simultaneously so they are not mutually exclusive. Therefore the probability of the collapse or destruction of technoindustrial civilization is improving over time as the number of ways that we can destroy ourselves increases and as ecological scarcity more firmly tightens its vice of necessity. We conclude that the Ragnarok thesis, on the basis of limitationism is true and that technoindustrial civilization is doomed.

As such, the entire ideological prop of modernism—the belief in unending technological progress, of perpetual growth and development, of the transcendence of the limits and necessities of nature and the creation of a world without end (Redclift, 1993)—*collapses*. Despite our technological sophistication and the supposed depth of our scientific understanding, classical thought, which recognized human and natural limits, can be seen as having the correct perspective on the human condition. In particular, orthodox neoclassical economics can be seen as rationally untenable and ultimately self-defeating. This alleged science justified the existence of a human techno-social system, capitalism, which arrogantly refused to live within limits. It is bankrupt. And as in the myth of Ragnarok, it too will disappear in the ruins of the system of which it is a part.

NOTES

1. Grossman and Krueger (1995) have examined the relationship between per capita income and environmental indicators such as urban air pollution, the state of the oxygen regime in river basins, fecal contamination of river basins and contamination of river basins by heavy metals. They found that economic growth produced an initial phase of environmental deterioration followed by a phase of improvement. This research is consistent with limitationism, which is essentially a thesis about the diminishing returns of economic growth. In the early stages of industrial development, industries are often highly polluting. Later, due to technological and economic efficiencies urban air pollution and environmental contamination can be reduced. Many polluting industries can also be transferred to the Third World. Grossman and Krueger do not consider this. Further, we examined in *Healing a Wounded World* (Smith et al, 1997) the environmental health of many of Sydney Australia's river systems. We quoted a large number of the nation's top water specialists who believe that many of the regions' rivers are in crisis. Attempting a statistical correlation between fecal contamination of water resources, for example, has its methodological difficulties. Many of Sydney and Adelaide's beautiful beaches (with high income foreshore areas) are highly fecally contaminated because of inadequate sewerage systems. Population levels also have a major impact, which Grossman and Krueger do not give adequate consideration to.
2. Ayres and Nair (1984) recognize that the feedback loop between price and technological development does not guarantee that the free market system will respond in time to the challenge of ecological scarcity: "If, as seems conceivable, the cost of the necessary investments starts rising rapidly just as fuel shortages begin to choke off economic growth, industrial societies could find themselves on a downward escalator from which a democratic, free-enterprise society might find it impossible to escape" (Ayers & Nair, 1984, 71). Price rises do not occur, according to the classic supply and demand analysis, until demand exceeds supply. For example, tropical timbers can be purchased fairly cheaply now even though the supplies are being rapidly depleted and the resource will be exhausted by 2030.

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