



Full citation: Jackson, Tim. "Sustainability and the 'Struggle for Existence': The Critical Role of Metaphor in Society's Metabolism."
*Environmental Values* 12, no. 3, (2003): 289-316.
http://www.environmentandsociety.org/node/5887

# Sustainability and the 'Struggle for Existence': The Critical Role of Metaphor in Society's Metabolism

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ABSTRACT

This paper presents a historical examination of the influence of the Darwinian metaphor 'the struggle for existence' on a variety of scientific theories which inform our current understanding of the prospects for sustainable development. The first part of the paper traces the use of the metaphor of struggle through two distinct avenues of thought relevant to the search for sustainable development. One of these avenues leads to the biophysical critique of conventional development popularised by 'ecological economists' such as Georgescu-Roegen and Daly. This critique suggests that modern economic systems have gone astray by failing to respect the biological and physical limits to development and that they should be adapted to make them more like ecological systems. The other avenue leads to the modern insights of evolutionary psychology. These latter insights suggest that in certain key respects, the economic system (and actors within it) are already behaving more or less like an ecological system, driven as they are by evolutionary imperatives. Consequently, this second avenue appears to offer far bleaker prospects for achieving sustainable development than the first. However, the final part of the paper re-examines the historical roots of the metaphor itself, and suggests a number of ways in which a critical response to those historical roots might influence our understanding of the prospects for sustainable development.

KEYWORDS

Sustainable development; struggle for existence, Darwin, Malthus, evolutionary psychology.

*Environmental Values* **12** (2003): 289–316

## INTRODUCTION

On 29 May 1886, the Austrian physicist Ludwig Boltzmann gave a lecture to a meeting of the Imperial Academy of Science in Vienna setting out his probabilistic interpretation of the second law of thermodynamics. In the course of that lecture, he argued that the 'struggle for existence' of animate beings is essentially a struggle for 'available energy' coming directly or indirectly from the sun (Boltzmann 1886).[1] In so doing, Boltzmann created a metaphorical 'bridge' between Darwin's theory of evolution, and the emerging physics of thermodynamics and statistical mechanics. At the same time, he laid down the foundations for a line of reasoning concerning the environmental limits to human development which has as much (or possibly more) relevance now as it did when Boltzmann was writing over a century ago.

A part of the aim of this paper is to set out in more detail the implications and relevance of these two aspects of Boltzmann's work. In the section following this introduction, I summarise briefly the development of a line of thinking which links Boltzmann's theory to a rather modern critique of economic development from a 'biophysical' perspective; and in a following section I examine some of the equally modern implications of Boltzmann's Darwinian insights.

The metaphorical substance of Boltzmann's bridge between the physical and the biological sciences is provided by the phrase which Martinez-Alier (1987) described as 'that dreadful social-Darwinist expression': the struggle for existence. It is probably true, as Martinez-Alier points out, that this metaphor attained its greatest notoriety through the movements of social Darwinism in the late nineteenth century and eugenics in the early twentieth century; the culmination of which lay in the politics of the Nazi Germany during the Second World War. However, it is also a part of the aim of this paper to show that this specific metaphor has informed and continues to inform much of our scientific view of the physical world. Indeed almost all of the theories through which we approach an understanding of the world and our own place in it are shot through with the idea of nature as a struggle, and existence as a kind of contest. Furthermore, a later section of the paper shows that this concept predates Darwin considerably. In particular, I highlight the crucial contribution of Malthus to this debate, and outline some of the influences to which Malthus himself was responding.

The paper is, therefore, at one level a historical exploration of the emergence of a certain key metaphor within an important set of scientific ideas. This historical analysis is not entirely original to the present paper. In fact, there is a veritable mountain of literature relating to the impacts of Darwin on modern intellectual thought, and at least a medium-sized hill of literature relating to the influence of Malthus on Darwin. In part, this paper is an attempt to collate and synthesise some of that earlier work, in particular as regards the influence of the central Darwinian metaphor.

The aim of the paper extends beyond historical exegesis, however. More particularly, I am concerned to explore the prospects for sustainable development which are offered to us under the framework of modern science. The biophysical critique of economics – which flowed, in part, from Boltzmann's work – has given rise to the idea that sustainability is mostly a question of persuading economic systems to behave a bit more like biological systems. But the views from evolutionary psychology – which also have roots in Boltzmann's insights – suggest that in certain crucial ways, the human economy is already behaving very much like a biological system.

This latter view, as I have argued elsewhere (Jackson 2000) and re-iterate in this paper, makes the prospects for achieving sustainable development appear considerably more tenuous than is generally recognised within the modern environmental debate. The more defensible view still appears to be one which is profoundly neo-Malthusian in nature; a view which is nonetheless at odds with most conventional ideas about achieving sustainability. The final section of this paper explores the possible responses to this rather bleak view of the prospects for human development.

## ENTROPY AND THE ECONOMIC PROCESS: THE BIOPHYSICAL CRITIQUE OF DEVELOPMENT

Boltzmann was by no means the only person to relate the struggle for existence to the struggle for physical resources. A similar point was made by Joly in a paper first published shortly after Boltzmann's 1886 address to the Imperial Academy of Science (Joly 1890); and the point was elaborated further by Lotka (1925) in an influential contribution to which I shall return later on. However, the Boltzmann formulation is of particular interest here because he set it specifically in the context of his probabilistic interpretation of the concept of entropy. Under this interpretation, the evolution of physical systems is characterised in general terms by a movement towards less ordered (and therefore more probable) states and away from more ordered (and therefore less probable) states.

The universal tendency anticipated by the second law of thermodynamics is thus towards an entirely random distribution of matter in which 'all tensions that might still perform work and all visible motions in the universe would have to cease' (Boltzmann 1886, p. 19). Helmholtz coined the term 'heat death' for the ultimate fate of the universe, and the prospect of its inescapable advance pervaded both philosophy and literature at the turn of the twentieth century. Roszak, for example, alleges that it accounts for 'the aura of invincible pessimism that surrounds the poetry of Housman and Dowson, the historical studies of Henry Adams and Oswald Spengler, the plays of Eugene O'Neill and the novels of Thomas Hardy' (Roszak 1992, p. 58).

The bleakness of this long-term prognosis was at one time regarded as indication of a conflict between Darwin, who predicted constant evolution towards more and more complex forms of life, and the laws of thermodynamics. In fact, as Boltzmann was undoubtedly aware, there is no such contradiction. In particular circumstances, namely when a system is held away from thermodynamic equilibrium by an external source of available energy, it is possible for that system to preserve or even increase order and complexity within the system boundary. Indeed, later work by Nobel-laureate Prigogine and his co-workers at the 'Brussels school' of thermodynamics suggests that the spontaneous emergence of ordered structures is to be expected in such systems (Nicolis and Prigogine 1977, Prigogine and Stengers 1984). But the emergence of complexity within the system boundary can only occur in the presence of continuing inputs of available energy from outside the system, together with mechanisms which 'pump out' from the system the entropy associated with converting this available energy into useful work (Odum 1983).

These are precisely the conditions which allow for evolution on planet Earth. For us, thermodynamic equilibrium is avoided because of the available energy continually reaching us from the sun. In order to exploit this energy, as Boltzmann put it, 'plants spread their immense surface of leaves and force the sun's energy … to perform in ways as yet unexplored certain chemical syntheses of which no one in our laboratories has so far the least idea'. A century later, we have considerably more idea about the complex process of photosynthesis than biologists and chemists did in Boltzmann's day. Yet it remains as true now as it was then that the 'products of this chemical kitchen constitute the object of struggle in the animal world' (Boltzmann 1886, p. 25).

We also know that the human species is by far the most successful species in that struggle, having managed to appropriate an estimated 40% of the products of photosynthesis for its own ends (Vitousek et al. 1986). In addition to this more or less direct solar resource, humanity also uses considerable quantities of indirect solar energy stored up in the form of fossil fuels. On the back of this massive store of available energy, society has been able to gain access to mineral resources which are simply unavailable to most other species; and using these resources has fabricated a whole range of new materials, new tools, new products: a vast array of manufacturing facilities and consumption goods providing a wide variety of services to humanity.

In a sense, it appears almost as though the human species has made a dramatic escape from the struggle for existence which seems to attend every other species on the planet. The extent to which modern economies have increased longevity, lowered infant mortality, improved health, reduced the need for manual drudgery, and now spend an increasing proportion of their income in the pursuit of luxury goods rather than subsistence needs is startling evidence of a species apparently free from the struggles which attend the rest of nature. Of course, this is much truer of the developed economies of the West than it is of the developing economies. However, if the conventional view of economic progress is to be

believed, it is only a matter of time before the developing countries catch up with western levels of affluence.

However, the message from the modern environmental debate is that there is a price to pay for this affluent lifestyle. Resource depletion, environmental degradation at every turn, and rates of species extinction which may turn out to be unprecedented in human history are not so much the unfortunate side-effect as the inevitable accompaniment to a society profligate of material usage and an economy founded on relentless growth. It is not the purpose of this paper to expand upon these environmental impacts. There are plenty of other authors who have done that. From Rachel Carson's ground-breaking *Silent Spring* (Carson 1962) and Paul Ehrlich's apocalyptic *The Population Bomb* (Ehrlich 1968), through the Club of Rome reports (Meadows et al. 1983, Meadows et al. 1992), to an explosion of warnings from the Worldwatch Institute (e.g. Brown et al. 1990) amongst many others,[2] the litany of environmental dangers from conventional development is now exhaustively documented. A particularly colourful trot through the range of modern ecological concerns is provided by Reg Morrison's *The Spirit in the Gene* which describes humanity as a 'plague mammal' – nature's 'prattling prodigy' – and takes what is almost a perverse delight in documenting the damage caused by the human species (Morrison 1999).

From the biophysical perspective, the scale and scope of this environmental degradation is not so much an accidental feature of human development, as its inevitable consequence. This view was most famously espoused by Georgescu-Roegen (1971) who once argued that the net effect of human activity is to turn valuable resources into waste. His landmark publication *The Entropy Law and the Economic Process* (Georgescu-Roegen 1971) criticised conventional economics for failing to take an adequate account of physical laws – in particular the second law of thermodynamics – and inspired a whole generation of writers to attack the traditional model of economic development from a biophysical perspective.[3] Amongst these writers, perhaps the most well-known critique is the one presented by the 'ecological economist', Herman Daly, whose early work (Daly 1973) called for an end to economic growth. This view is moderated in Daly's more recent writing to the extent that he argues for an economic system stabilised with respect to material throughputs (Daly 1996).[4]

Much of this biophysical critique is directed at the failure of conventional economic institutions, policies and pricing structures to take an adequate account of the biophysical limitations to human activity. Responses to these failings include a wide variety of suggestions ranging from the vigorous pursuit of technological improvements in resource productivity (von Weizsäcker et al. 1997, Lovins et al. 1999), through adjustments to pricing structures (Pearce et al. 1989) and the basis of taxation (von Weizsäcker 1987), to calls for a more radical re-orientation of the economic and social system (Douthwaite 1992, Gowdy 1994, Norgaard 1994, Trainer 1995, 1996).

One particular response which has emerged in the last decade goes under the name of 'industrial ecology' (Graedel and Allenby 1996, Socolow et al. 1994, Ayres and Ayres 2002). The fundamental tenet of industrial ecology is that the appropriate response to the environmental crisis is to redesign industrial and economic systems in such a way as to make them more like ecological systems. Eco-restructuring is to be achieved, for example, by recovering, re-using and recycling more materials, improving resource use efficiencies, and developing new technologies based on renewable flows of energy and material through the environment (Ayres and Simonis 1994).

There is clearly considerable scope for improving the resource efficiency of some industrial processes, and for improving the closure of some material cycles. At the same time, it needs to be recognised that the second law of thermodynamics places clear physical limitations on the possibilities for material closure.[5] Furthermore, as I have argued in more detail elsewhere (Jackson and Clift 1998, Jackson 2000), the industrial ecology literature, like much of the technological literature relating to sustainable development, fails to offer a credible theory of agency: a mechanism for the changes in both producer and consumer behaviour which are necessary if substantial reductions in material throughput are to be achieved. In fact, the most pervasive – if not the most persuasive – theory of social behaviour available to us in addressing such questions does not derive from the modern environmental critique of conventional development at all. Rather it is to be found within the second strand of intellectual thought towards which Boltzmann pointed in his 1886 lecture on the second law of thermodynamics. It is to this body of work that we now turn.

## ENTER THE RED QUEEN: FROM SOCIAL DARWINISM TO EVOLUTIONARY PSYCHOLOGY

When Boltzmann aligned the struggle for existence with the struggle for available energy, he was quite consciously creating a link between biological science and physics. He was a fervent admirer of Darwin's work (Flamm 1983, Coveney and Highfield 1991) and one of his declared intentions was to mirror for physical systems the evolutionary mechanism which Darwin had provided for biological systems. 'If you ask me for my innermost conviction whether it will one day be called the century of iron, or steam, or electricity', he told the Imperial Academy of Science, 'I answer without qualms that it will be named the century of the mechanical view of nature, of Darwin' (Boltzmann 1886, p. 15). In fact, he lost no opportunity to praise the application of what he saw as mechanical reasoning to biological science and to expand on the ways in which Darwin's theory was relevant not only to the biological evolution of species, but also to social and psychological development (Boltzmann 1900, 1905).

Although these remarks clearly prefigure some of the insights of modern thinking in evolutionary psychology and epistemology, Boltzmann was not unique in applying the Darwinian mechanism to social and psychological development. Darwin himself went some way towards it in *The Descent of Man* first published in 1871 (Darwin 1896); and the same theme was taken up by a number of social theorists of the late nineteenth century: Spencer, Gumplowicz, Lapouge, for example (Hawkins 1995). Rather the importance of Boltzmann's remarks lies in two aspects: firstly, in his association of the evolutionary mechanism with the use of physical resources; and secondly in the influence which Boltzmann himself had on other twentieth century scientists.

In this latter context, it is worth mentioning in particular, the shock and disappointment of the young Erwin Schrödinger who had enrolled for Boltzmann's course at the University of Vienna in 1906 only to find that the great physicist had committed suicide shortly before the beginning of classes. Moore (1989) describes Boltzmann as Schrödinger's 'scientific grandfather', and Schrödinger himself wrote that 'for me, his range of ideas played the role of a scientific young love, and no other has ever again held me so spellbound' (Schrödinger 1929).

Schrödinger received the Nobel prize in physics in 1933 for his contributions to quantum mechanics. But he is perhaps equally well-known among biologists for his landmark essay *What is Life?* first published in 1944 in which he set out clearly the relationship between biological life and entropy. This essay was to have a profound impact on a whole generation of molecular biologists, and was influential in unravelling the structure of DNA and the development of the science of genetics. Interestingly Schrödinger was also responsible for another landmark essay entitled *Mind and Matter* in which he pursued the relationship between the Darwinian selection mechanism and behavioural characteristics (Schrödinger 1967). Schrödinger is thus a kind of vital intellectual link between Boltzmann's insights and modern theories of genetics and psychology to which I shall return below.

However, from the perspective of sustainable development, it is Boltzmann's link between Darwinian selection and resource appropriation which is perhaps of the greatest importance. In an influential elaboration of this idea, Lotka reflected on the 'selfish efforts of each organism and species to divert to itself as much as possible of the stream of available energy' to argue that the law of evolution (i.e. of selection) might possibly be cast as the law of maximum energy flux (Lotka 1925). In his view, a species successful in diverting available energy will 'tend to grow in extent (numbers) and this growth will further increase the flux of energy through the system'. He accepted that efficiency in utilising the energy flow and a better husbandry of resources 'must work to the advantage of a species talented in that direction', but argued nonetheless that the general tendency in such systems is to appropriate the maximum possible share of the available energy resources.

Through Lotka's elaboration of Boltzmann's insight, the 'success' of the human species in appropriating vast resources of available energy, appears to be nothing more nor less than the operation of Darwinian evolution. Since the direction of an available energy flux towards individual or collective ends necessarily involves transformation (and degradation) of the energy flow, it is also possible to construe Lotka's principle as a 'maximum entropy production' principle: ecological systems behave in such a manner as to maximise the production of entropy under the constraint of the available energy. To the extent that the degradation of energy and the dissipation of materials into the environment is responsible for the environmental crisis, we are left with the unpleasant conclusion, that humanity's impact on the environment is itself a consequence of the evolutionary process.

Lotka was not the only person to draw attention to the similarity between economic behaviour and ecological behaviour in terms of competition for the available resources. A number of other writers, both before Lotka and since, have picked up on the same theme.[6] Joly believed that 'in the present and ever-increasing consumption of inanimate power by civilised races, we see revealed the dynamic attitude of the organism working through the thought processes' (Joly 1915). In the 1970s and 1980s Hirshleifer revisited the same general ideas. 'Competition [for scarce resources] is the all-pervasive law of nature–economy interactions', he writes (Hirshleifer 1978); and later remarks that the 'evolutionary approach suggests that self-interest is ultimately the prime motivator of human as of all life' (Hirshleifer 1982). Essentially the same insight inspires the 'natural selection' ideas of Friedman's economics (Friedman 1953), which in their turn had a profound impact on the monetarist economic policies of the 1980s.

The explicit application of the Darwinian metaphor to social evolution was not new to Lotka, of course. Spencer had already made a conspicuous attempt to apply evolutionary dynamics to social theory, in which the struggle for existence was afforded a primary place. For Spencer, this struggle – though at times involving violent conflict – was an indispensable means to social progress. He argued that 'competition in war is the chief cause of social integration' (Spencer 1878); and that 'the immediate cause for the improvement in quantity and quality of productions is competition' (Spencer 1969).

Gumplowicz applied the same kind of reasoning to social evolution. Emphasising that natural selection operated on groups rather than individuals, he formulated a bleak view of the behaviour of modern nation states in which 'it is generally recognised that states oppose each other like savage hordes; that they follow the blind laws of nature; that no ethical law or moral obligation, only fear of the stronger, holds them in check' (Gumplowicz 1963, p. 229). An equally intensive conflict arises between the various groups within each state (Hawkins 1995, p. 56). According to Gumplowicz, the driving forces for competition and warfare are the generally insatiable desires of human beings and their exploita-

tion of the labour of others in seeking to satisfy these desires (Gumplowicz 1898, 1963). Of these two factors, the primary cause of social conflict is the drive to satisfy current material needs and to ensure the satisfaction of future needs.

Resonances with the Brundtland definition of sustainability are striking here. Sustainable development, argued the Brundtland Commission, is development which 'meets the needs of the present generation without compromising the ability of future generations to meet their own needs' (WCED 1987). To the extent that the Brundtland Commission portrays sustainable development as a laudable aim, it is of course advocating something recognised explicitly by the social theorists of the nineteenth century as a primary goal of human societies. Where Brundtland sees this strategy as a key to harmonious global development, however, Gumplowicz saw it as a mechanism for a rather bleak vision of social evolution. The distinctive ingredient in the Gumplowicz analysis – which is missing in the Brundtland analysis – was the recognition that ethnically and ideologically distinct social groups were all engaged separately in pursuing this aim under conditions of scarcity. It was precisely these conditions which provided the mechanism for social evolution.

Moreover, this evolution cannot cease. For nature has provided that man's needs shall not stand still. Higher and 'nobler' wants are constantly awakened. At the very point where natural ethnic divisions would disappear, artificial 'social' divisions arise to perpetuate the antagonism of human groups. (Gumplowicz 1963, p. 229)

In contrast to Spencer's view of social evolution as a process leading to the continual progress of society and the improvement of humanity (albeit by some morally repugnant means[7]), Gumplowicz presented a cyclic view of change in which 'communities expanded through conquest and assimilation up to a certain point, beyond which they disintegrated and the process recommenced' (Hawkins 1995, p. 57). Neither of these views of evolution, of course, is similar to the development path envisaged by the Brundtland Commission, which portrays sustainable development as a broadly egalitarian affair. Yet, it is clear that Gumplowicz's vision of social development possesses a sophistication that is somehow lacking in the Brundtland analysis. In particular, his analysis of the impact which the human pursuit of material welfare has on intra-generational equity, provides more of an explanation of the historical struggles for resources between nations than the Brundtland report even attempts. It should also serve as a warning that simplistic idealisations concerning the distribution of present and future resources are unlikely to be successful.

In one sense, it is strange that the literature from social-Darwinism should have been so strenuously excluded from much of the environmental literature; particularly since the insights regarding the competition for natural resources so clearly inform the debate. However, in another sense, the reasons for this almost wilful negligence are clear. Martinez-Alier, for example, in an excellent and generally thorough review of the roots of modern ecological economics, makes

only grudging reference to the social theory of the late nineteenth century. 'Social Darwinism has inevitably cropped up in my research,' he writes, 'against my wishes, and against the wishes of some of the other authors [that he examines] … who held strongly egalitarian views' (Martinez-Alier 1987, p. 10). Spencer himself is mentioned only once in the entire book, in spite of his prodigious output and substantial influence on social theory in the late nineteenth and early twentieth century. Gumplowicz is not mentioned at all.

The reasons for this reticence are quite clear. Primarily, it is motivated by ideological concerns that the implications of the theory are morally unacceptable. History, indeed, has reinforced this message. From the social Darwinism of the late nineteenth century and the eugenics movements of the early twentieth century sprang the politics of German National Socialism in the nineteen thirties and forties; politics which led ultimately to the Nazi concentration camps of the second world war. By 1945, the twentieth century had conspired to realise the worst extremes of the social Darwinist vision, and in recognition of the horrific reality, civilised society naturally shied away from it (Kevlar 1985).

Perhaps a further reason for rejecting the insights of social Darwinism into the relation between social evolution and natural resources is a belief that the scarcity under which nation states laboured in the late nineteenth century has become less of an issue in the late twentieth century. This may be to some extent true of the developed economies. But in the developing economies, where life expectancy is lower than in the West, infant mortality is higher, malnutrition and starvation are rife, and living conditions are poor for large proportions of the population, the elements of social struggle are all too visible in the form of political fragmentation: internal as well as external conflict. From the perspective of nineteenth-century social theory, these inequalities are not only a natural consequence of the struggle for existence, manifest at the level of human society, they are also the engine of progress in the West.

This unpleasant conclusion has not gone entirely unnoticed by modern observers. Gandhi asked several decades ago: 'if it took England the exploitation of half the globe to be what it is today, how many globes will it take India?' More recently, Athanasiou's *Slow Reckoning: The Ecology of a Divided Planet* argues that the environmental crisis and the humanitarian crisis facing the developing world are quite simply two faces of the same coin, and that the solution to one will not be found without a solution to the other (Athanasiou 1998). Douthwaite makes a similar point in the gloriously subtitled *The Growth Illusion: How Economic Growth has Enriched the Few, Impoverished the Many, and Endangered the Planet* (Douthwaite 1992).

In spite of all our moral qualms, therefore, it is clear that nineteenth-century social theory has something to offer to the sustainability debate: in particular, the notion that there is some kind of relationship – albeit not necessarily a happy or desirable one – between social evolution and the appropriation of material resources. We may argue vehemently that the conclusions drawn about this

relationship by social Darwinism (and the movements which followed it) are morally indefensible. It may well be true that social Darwinism saw in the maximum power principle an apparently 'natural' justification for the appropriation of resources by a powerful minority and used this to support 'the reactionary political viewpoints of the privileged classes' (Campbell 1965). Nevertheless, it is clear that some kind of perspective on the relationship between social behaviour and material resources is necessary if we are to make sense of the demands which sustainable development places on us.

If anything, this conclusion is strengthened by recent intellectual developments in the fields of genetics and psychology. Social Darwinism itself may well have gone 'underground' in the years following the Second World War. But the elements of a neo-Darwinist view of human nature were never far below the surface. For example, the humanist Julian Huxley remained a proponent of the eugenic agenda even as late as the 1960s. In his Galton Lecture, delivered on 6 June 1962, he argued that 'we must bring home to the general public the possibility of real genetic improvement, the burden it could lift off human shoulders, the hope it could kindle in human hearts' (Huxley 1964). Admittedly, Huxley's agenda was rather to mitigate than to promulgate the worst excesses of the Darwinian 'struggle for existence'; and yet his means for achieving this were as dubious as those of some of his predecessors. In spite of his 'humanism', he was still able to argue that 'we must continue to support negative eugenic measures, especially perhaps in respect of the so-called social problem group' (Huxley 1964, p. 282).

Shortly afterwards, in 1975, Wilson published a landmark volume on *Sociobiology*, a new science of human behaviour based firmly on the newly developed neo-Darwinian theory of genetics. This thoroughly modern scientific theory recast the Darwinian model of evolution as a process of genetic selection. In fact, although Darwin formulated a mechanism for natural selection based on the fitness of individual variations to survive in the struggle for existence, he never satisfactorily answered the question of how variation occurred in the first place. It was Schrödinger's influential *What is Life?* which popularised the idea that the mechanism of variation was in fact pure chance operating at the molecular level of genetic mutation. Particular mutations were then selected, or not, depending on whether or not the new characteristic provided by the mutated gene aided or impeded the organism in the struggle for existence. Although this theory was well-established as an explanatory mechanism for the evolution of physical characteristics in the natural world, the idea that the same mechanism could be used to explain human traits and behavioural characteristics was greeted with a mixture of horror and derision.

In the year after Wilson's book was published, a young Oxford scientist named Richard Dawkins published a book called *The Selfish Gene*, which was to have an even greater impact on the debate about human nature (Dawkins 1976). Dawkins argued that because selection occurs at the level of individual

genes, and since the traits and characteristics of an organism were essentially selected on the basis of this variation at the genetic level, it makes sense to view the gene as the fundamental evolutionary unit. In other words, it is not so much that genes are part of our makeup as biological organisms; it is more that we are the vehicles which genes employ as the means to reproduce themselves in future generations.

In the hands of the new discipline of evolutionary psychology these kinds of insights have become a theory about human nature. It is not possible within the scope of this paper to set out all the details of this new view of human nature. Ridley's exposition is, however, masterful. In *The Red Queen*, Ridley first outlines how sexual reproduction evolved in the biological world primarily as a means of fending off parasitic infection, and ensuring successful genetic succession (Ridley 1994). From these biological propositions, Ridley sets out the evolutionary argument that human nature is fundamentally determined by the strategies and ploys of the 'selfish gene'. By definition, those genes that have survived thus long are those which have provided traits and characteristics which have increased the chances of genetic succession. Genetic succession depends upon successful sexual reproduction, and human nature is therefore determined by the continuing need to 'position' ourselves in relation to the oppositive sex, and with respect to our sexual competitors.

Moreover, this fundamental element of sexual competition does not diminish over time. Rather, we find ourselves having to run faster and faster as time goes by, like the Red Queen in Lewis Carroll's *Through the Looking-Glass*, precisely because our sexual competitors are all engaged in the same unending struggle. This insight was first put forward by the biologist Van Valen in the 1970s, after he discovered that the probability that a family of animals will become extinct does not depend on how long that family has already existed. For Van Valen, this fact 'represented a vital truth about evolution that Darwin had not wholly appreciated. *The struggle for existence never gets easier*. However well a species may adapt to its environment, it can never relax, because its competitors and its enemies are also adapting their niches.' (Ridley 1994, pp. 61–2, my italics)

If this idea seems familiar to a modern reader, it is perhaps because the same mechanism is quite clearly at work in the market place. Indeed, it had already been incorporated into the monetarist economics of Milton Friedman (1953), and has since become an inalienable feature of life in the world of corporate business. In the cut and thrust of the financial markets only the fittest companies survive; and they only survive through a process of continual adaptation in a constant struggle to stay ahead of the competition.

Interestingly, the same idea of a progressive struggle for positioning amongst our social peers is to be found in twentieth century social theory. In *The Social Limits to Growth*, published in 1977, Fred Hirsch sought to explain why modern societies appeared to be addicted to material consumption. Hirsch argued that once basic material needs are met, we are led to consume not on the basis of the functional value of material goods, but on the basis of their value in 'positioning'

us with respect to our fellow humans. A part of this attempt to position ourselves is the need to identify ourselves with and consolidate ourselves within a particular social group or community. But there is another, perhaps more sinister aspect of 'positional' consumption. A part at least of the value of positional goods is associated with a continual, ongoing struggle to maintain or improve our status within the social group.

In the absence of the insights from evolutionary psychology, this Red Queen race against our social peers could be construed simply as a meaningless 'zero-sum game'. Given appropriate public education or a change in social attitudes it could perhaps be eliminated, reducing at a stroke the demand for consumption goods and the associated environmental impacts. Neo-Darwinian theories of human behaviour appear to exclude that possibility. They suggest that, far from being a meaningless habit, 'positional' consumption plays a vital role in the evolutionary strategy of the selfish gene. We are driven to consume, according to this theory, because of a continuing need to position ourselves in relation to the opposite sex and with respect to our sexual competitors. This strategy offers us – or rather it offers our genes – the best chance of successfully passing on genetic material to the next generation.

In one sense, evolutionary psychology appears to turn Boltzmann's insight on its head. Not only is the *object* of the struggle for existence access to material resources; but equally, the *objective* of the evident struggle for material resources is to ensure genetic succession in this and in subsequent generations. That this process becomes more and more intense as time goes by is nothing more nor less than a perverse characteristic of the evolutionary mechanism.

The framework of evolutionary psychology is so reminiscent of earlier social theories that sprung from Darwinism that it is equally tempting to repudiate these kinds of insights as morally and politically unacceptable. Yet, the fact of the matter is that they do provide us with some kind of explanation of the drive towards ever increasing consumption which is evident in the western world, just as social theories like those of Gumplowicz provide us with some kind of explanation of the pernicious levels of inequality which persist between developed and developing economies. If we are serious about addressing either of these issues we would do well at least to consider explanations of these phenomena which claim some kind of intellectual credentials in the body of contemporary science.

One thing is abundantly clear, the prospects for achieving sustainable development offered within this intellectual framework are considerably bleaker than those offered by the biophysical critique of the previous section. Far from behaving differently from ecological systems, the economic system is, according to this viewpoint, operating under evolutionary imperatives shared with every other species on the planet. Unfortunately, those imperatives appear to be driving us faster and faster towards ever higher levels of consumption, and the planet towards ecological disaster.

In the final section of this paper, I shall address some of the possible avenues through which the bleakness of this situation might be mitigated. Before doing so, however, I want to examine in more detail the roots of the metaphor which has proved so influential in the suite of modern scientific theories through which, at present, we view the world.

## NATURE AS STRUGGLE: THE ROOTS OF THE DARWINIAN METAPHOR

The metaphor of the struggle for existence occupies an absolutely critical place in Darwin's theory of evolution. Early in *The Origin of Species* – which incidentally was subtitled 'the preservation of favoured races in the struggle for life' – Darwin writes:

> Nothing is easier to admit than the struggle for life, or more difficult – at least I have found it so – than constantly to bear this conclusion in mind. Yet unless it be thoroughly engrained in the mind, I am convinced that the whole economy of nature, with every fact on distribution, rarity, abundance, extinction, and variation, will be dimly seen or quite misunderstood. (Darwin 1859, p115)

Not only was this idea one of the inspirations for Darwin's thought, but it occupies a critical structural role in the theory. Hawkins identifies four key elements of Darwinian evolutionary theory:

> (1) an assumption that biological laws governed the whole of organic nature, including human beings; (2) a claim that the pressure of population growth on resources generated a struggle for existence; (3) a belief that biological traits conferring an advantage on their possessors in this struggle could, through cumulative selection and inheritance by their descendants, spread throughout the population; (4) a belief that this process, over time, accounted for the emergence of new species and the elimination of other life-forms. (Hawkins 1995, p 49)

The nature of the struggle itself has remained a bone of some contention amongst historians of science. Darwin appears to use the term to refer variously: to the struggle of animate beings generally in the face of a hostile environment; to the struggle between species to occupy particular niches or to colonise limited resources; and to the intra-species struggle for sexual selection. In Chapter 3 of *The Origin* he writes:

> I should premise that I use the term Struggle for Existence in a large and metaphorical sense, including dependence of one being on another, and including (which is more important) not only the life of the individual, but success in leaving progeny. Two canine animals in a time of dearth, may by truly said to struggle with each other which shall get food and live. But a plant on the edge of a desert

> is said to struggle for life against the drought...a plant which annually produces a thousand seeds, of which on average only one comes to maturity may be more truly said to struggle with the plants of the same and other kinds which already clothe the ground. (Darwin 1859, p116)

Some historians have accused Darwin himself of being unclear about the kind of struggle that he was envisaging, whether literal or metaphorical. Gale, for example, argues that Darwin creates the image 'through his continual use of highly dramatic language representing the life of organisms in nature as some heroic war' of a very literal and highly vicious struggle for life 'an image which seems to pervade the *Origin*'. But Darwin's metaphorical usage of the term – the usage which he claims for it as a structurally important element of his theory – turns out, according to Gale 'to have very little relationship to the phenomena he wishes to describe' (Gale 1972, p322). In spite of this ambiguity, there is generally little disagreement amongst historians that the concept of nature as a struggle was one of the key ingredients of the theory of evolution. As we have seen in the preceding section of this paper, it remains one of the key ingredients of twentieth-century neo-Darwinian science.

There is also a certain amount of disagreement as to the source of this key metaphor in Darwin's writing. In a now widely-cited passage in his *Autobiography* Darwin himself unequivocally identified Malthus's *Essay on the Principle of Population* as providing the crucial inspiration for his theory.

> In October 1838, that is, fifteen months after I had begun my systematic enquiry, I happened to read for amusement 'Malthus on Population', and being well prepared to appreciate the struggle for existence which everywhere goes on from long-continued observation of the habits of animals and plants, it at once struck me that under these circumstances favourable variations would tend to be preserved, and unfavourable ones to be destroyed. The result of this would be the formation of new species. Here then I had at last got a theory by which to work... (Darwin 1897, p. 68)

At the point at which Darwin read Malthus's essay, he had already become convinced that evolution occurred through a process of natural selection. What he lacked in formulating a scientific theory was the mechanism by which selection occurred. According to many historians (and Darwin's own testimony) it was Malthus who provided him with this mechanism (e.g., Gale 1972, Schweber 1977, Young 1969).

Bowler (1976), however, has argued against this simplistic view of a straight transfer of metaphors from Malthus to Darwin, because of the confusion that exists between two different notions of struggle. One of these notions refers to the struggle to survive which arises as a result of the shortage of food; the second refers to the notion of struggle as a (sometimes brutal) competition between species and individuals. Malthus's essay (as we shall see below) is generally

concerned with the former notion of struggle. But as Bowler points out, it is in theory possible to conceive of a world in which this kind of struggle does not necessarily give rise to a competitive struggle (Bowler 1976, p 634). The fact that neither Darwin nor the social Darwinists did conceive of this possibility, and that they generally confused the two notions of struggle in their writing is a point to which I shall return later.

Again, the historical disagreements appear minor in the light of the generally accepted fact that Malthus did influence Darwin.[8] One of the factors which speaks in favour of this idea is the quite extraordinary prominence which the debate over Malthus's *Essay* achieved in early nineteenth-century social thought. Originally published in 1798, Malthus's book was re-worked and re-published six times in total between 1798 and 1826, and the thesis itself was published once again in 1830 under the title *A Summary View of the Principle of Population* (Malthus 1798, 1826, 1970). This extended process of revision and re-issues was due in part to the intense and prolonged debate to which his work gave rise in the early years of the nineteenth century; a debate which was to continue in one form or another for over two hundred years.

The *Principle of Population* is of course well known to environmentalists. One could almost argue that a Malthusian or neo-Malthusian position has continually defined the environmentalist position (Harvey 1974). A recent book from the Worldwatch Institute on the environmental challenges facing the world in the twenty-first century, entitled quite simply *Beyond Malthus*, provides telling evidence of the power of the Malthusian argument for over two centuries (Brown et al. 1999).

In its original form, Malthus's *Principle* was straightforward. Basing his reasoning on two premises – that 'food is necessary to the existence of man' and that 'the passion between the sexes is necessary, and will remain nearly in its present state', he went on to argue that the 'power of population is indefinitely greater than the power in the earth to produce subsistence for man' (Malthus 1798, pp. 11–13). The effects of this imbalance between our propensity to reproduce and the capacity of the earth to feed us implied, for Malthus, 'a strong and constantly operating check on population from the difficulty of subsistence'. This difficulty, he argued, was not only inevitable but was also the cause of considerable suffering in a large portion of mankind, just as it was for the rest of nature:

> The race of plants, and the race of animals shrink under this great restrictive law. And the race of man cannot, by any efforts of reason, escape from it. Among plants and animals its effects are waste of seed, sickness and premature death. Among mankind, misery and vice. The former, misery, is an absolutely necessary consequence of it. (Malthus 1798, p. 15)

The same point is echoed with remarkable accuracy in *The Origin of Species*, where Darwin writes:

> Hence, as more individuals are produced than can possibly survive, there must in every case be a struggle for existence, either one individual with another of the same species, or with the individuals of distinct species, or with the physical conditions of life. It is the doctrine of Malthus applied with manifold force to the whole animal and vegetable kingdoms. (Darwin 1859, p. 117)

For Malthus, the consequences of this line of reasoning were both social (political) and theological. His original motivation in writing the *Essay* had largely been to refute the currently fashionable utopian ideas of William Godwin and the Marquis de Condorcet on the possibility of indefinite progress and the perfectibility of man. Since humans were ultimately subject to the same struggle for existence that faced every other species, checks on the population would always be necessary. Malthus foresaw two different kinds of checks. 'Positive checks' were those that were essentially forced on humanity by nature, in the form of disease, war, starvation, and premature death. However, in the light of man's nature as a moral animal, it was also possible for human society to devise 'preventive checks' which could ease, although never eliminate, the suffering that arose.

The most important of these preventive checks for Malthus was the idea of 'moral restraint', in particular restraint from sexual activity, the delaying of parenting until later in life, and a prudential restraint from marriage. This was, to Malthus, particularly important in those poorer sections of the community where in his jaundiced view, fecundity was high, the standard of education low, and vice proliferated. The political consequence of Malthus's position was his vociferous opposition to the Poor Laws, the removal of subsidy from the less advantaged sections of the community. In his view, such subsidy could only encourage moral lethargy amongst people who needed to be educated in the exercise of moral restraint as the only means of reducing the suffering in their lives.

In summary, it is not only clear, but also unsurprising that Malthus should have been a formative influence on Darwin. The concept of a struggle for existence was exactly the mechanism Darwin needed to turn his ideas about natural selection into a scientific theory. Moreover, Malthus's influence on nineteenth century thought was extensive. Alfred Wallace, 'co-founder' with Darwin of the theory of natural selection, also admitted to being influenced by Malthus. Malthus's influence on social scientists such as Herbert Spencer was also profound (Hawkins 1995). Gale argues that Malthus did for social science what Darwin did sixty years later for biological science, namely to 'tear asunder the eighteenth-century vision of a designed, orderly, economical and divinely-inspired nature' and 'replace it with a nature in struggle and conflict' (Gale 1972, pp. 338–9).

In fact, this cannot be entirely true. As Gale himself points out, the image of nature in struggle was by no means confined to the social sciences. The poet, physician and philosopher Erasmus Darwin (Charles Darwin's grandfather)

described organic nature as 'one great slaughter-house, one universal scene of rapacity and injustice!' (Darwin 1800); and in a poem entitled *The Temple of Nature – or the Origin of Society*, published in 1803, he wrote:

> 'Air, earth, and ocean, to astonished day
> One scene of blood, one mighty tomb display!
> From Hunger's arm the shafts of death are hurl'd
> And one great Slaughter-house the warring world!'

A similar image of 'nature, red in tooth and claw' was later expressed, famously by Tennyson in his *In Memoriam A.H.H*, a homage to his friend Arthur Hallam, which very quickly became established as 'the representative poem of its age' (Peltason 1985, p. 3). Likewise the philosopher Hume in *Dialogues Concerning Natural Religion* published in 1799, argues that 'the whole earth … is cursed and polluted. A perpetual war is kindled among all living creatures.'

Moreover some of these references clearly pre-date Malthus' *Essay*. For example, almost a decade before the first edition, the Swedish botanist Linnaeus wrote:

> If a person were transported to our earth, what would he see? He would see all these animals not only gorging on the most beautiful flowers, but also mercilessly tearing each other to pieces: in a word, he would see nothing but a war of all against all … (Linnaeus 1790)

There is even evidence of a thesis very similar to the Principle of Population being presented forty years earlier than Malthus's essay. In 1758, a Danish clergyman named Otto Diederich Lütken published a paper in the Danish Norwegian Economic Magazine, entitled 'An Enquiry into the Proposition that the Number of People is the Happiness of the Realm, or the Greater the Number of Subjects, the More Flourishing the State'. The essay argues against this proposition on the grounds that 'as soon as the number exceeds that which our planet with all its wealth of land and water can support, they must needs starve one another out, not to mention other necessarily attendant inconveniences' (Saether 1993, p. 511). The essay even includes language suggestive of Malthus's notion of population checks. Whether or not Malthus was aware of this essay is of course a different question completely.

Two other important influences on Malthus are worth mentioning. The first of these is essentially a negative influence, namely that of Godwin, de Condorcet and the utopian ideal of indefinite perfectibility in human society. It was Malthus's concerns over the absurdity of these ideas which led him to write the *Essay* in the first place. In the eighteenth and early nineteenth century Malthus therefore played a role which might be described as directly analogous to the role played by certain key figures in the environmental debate today, arguing specifically from ecological grounds against the absurdity of the notion of indefinite growth.

The second influence concerns the theological implications of Malthus's *Essay*. Even taking into account his idea of moral restraints as a preventive check on population growth, Malthus argued that it was still impossible for human society to escape suffering; after all, he argued, restraint from physical passion was in itself a form of suffering. Thus, Malthus was left with a problem in theology: why should a caring God allow inescapable suffering? In response to this question, he devised a complex philosophical theodicy – a means of reconciling our conception of God with the existence (indeed, for Malthus, the inevitability) of suffering and evil.

The problem of evil had played an important role in both theology and natural philosophy since the time of Leibnitz. Published in 1710, Leibnitz's *Theodicy* argued that the world for, all its apparent ills, had to be the best of all possible worlds because it had been created by a divine and benevolent God – a view deliciously lampooned in Voltaire's *Candide*. Leibnitz's theodicy was not only influential in formulating the eighteenth-century notions of harmony which infused the writings of people like Godwin; it also provided the template for subsequent attempts to address the problem of evil. Malthus's attempt – which is more often than not forgotten or ignored by latter-day neo-Malthusians – was that suffering and evil provide the necessary stimulus to rouse man from his natural sloth, and achieve a higher purpose. The suffering that derived from the Principle of Population provided the incentive to moral restraint – the only thing that could alleviate the suffering.

For Darwin, the answer to the dilemma of the existence of suffering in a world created by a benevolent God was disturbing, but straightforward: there is no such God (Schweber 1977, p. 304ff.). Hume had already demonstrated the fallacious nature of Paley's popular 'argument by design' for the existence of God. But the Scottish philosopher had not demonstrated how the complexity of nature and the sophistication of the human mind could have come about without God. This was Darwin's crowning achievement. With the help of the Malthusian insight he constructed a theory which explained the process of evolution as the result of natural laws applied to inanimate matter. Within this framework, there was no longer any need for God; there was, in fact, no room for God.

This was Darwin's 'dangerous idea' (Dennett 1995); an idea which to this day pervades the neo-Darwinian literature on evolution (Dawkins 1986) and genetics (Silver 1998). Darwinism changed not only our ideas about nature, and our conception of our own place *in* nature; it changed our cosmology. It finally reduced our ontology to the pure materialism at which Newtonian physics had already hinted. As the playwright and pamphleteer Bernard Shaw remarked in the preface to his 'evolutionary play' *Back to Methuselah,* religion was finally 'knocked to pieces':

> and where there had been God, a cause, a faith that the universe was ordered, and therefore a sense of moral responsibility as part of that order, there was now an utter void. Chaos had come again. The effect at first was exhilarating: we had the

> runaway child's sense of freedom before it gets hungry and lonely and frightened … We were quite sure for the moment that whatever lingering superstition might have daunted these men of the eighteenth century, we Darwinists could do without God, and had made a good riddance of him. (Shaw 1921, p. 48)

Or as Nietzsche gleefully declared: God was dead.

## DISCUSSION

In this paper I have set out two lines of intellectual thought, each of which flows in part from Boltzmann's 1886 insight that the Darwinian struggle for existence, is the struggle for available energy. The first of these lines of reasoning led, via Prigogine, Georgescu-Roegen, and Daly to a modern critique of conventional development, in which economics is seen as failing to take an adequate account of the biophysical basis of society, and of the second law of thermodynamics in particular. Addressing this problem, it is often argued, requires us to re-orient the economic system in such a way that it behaves more like an ecological system. However, the second line of thought pursues Lotka, Schrödinger, and evolutionary psychology to suggest that in certain critical ways, the economic system is already behaving like an ecological system; and that the endless pursuit of material consumption by human beings is an expression of a neo-Darwinian competition for genetic succession in the unending struggle for existence.

Thus, it appears that our current scientific view of the world depends to a large extent on a suite of scientific theories – physics, thermodynamics, economics, ecology, evolutionary theory, psychology, sociology – whose intellectual roots are all closely woven together in a complex history of ideas dating back at least three centuries. Of particular importance in that melting pot of intellectual ideas is the central evolutionary metaphor; a metaphor whose roots are substantially pre-Darwinian in origin.

Within the framework of this complex world-view there remains very little room for the notion of sustainable development, at least in so far as it is generally envisaged. The implications of current technological and economic development paths are already clear. Mounting environmental problems, unprecedented rates of species extinction, and a degree of social and political fragmentation that is reinforcing unconscionable inequalities within and between nations. To suggest that such a situation could easily be ameliorated through the introduction of new technologies or by relying on virtually unprecedented behavioural shifts appears as utopian as the eighteenth-century social theorists Malthus was anxious to refute. As Richard Dawkins has recently pointed out 'sustainability doesn't come naturally' to the human species (Dawkins 2001).

So what, if anything, are the prospects for moving forwards from this point? It seems to me that we are faced with essentially three possible avenues of

response. The first is to accept the conceptual framework and to construe the lessons of the biological sciences and of evolutionary psychology in particular as casting serious – possibly even terminal – constraints on the project of conceiving sustainable development. This is the avenue pursued by Reg Morrison in his apocalyptic *The Spirit in the Gene* (Morrison 1999). He casts humanity as a 'plague mammal', nature's 'prattling prodigy', rejects all notions of social or spiritual purpose, and suggests that the only relevant policy question is how to manage the inevitable collapse of the population curve.

A perverse variation on this theme, set out in Easterbrook's utopian *A Moment on Earth*, decries the neo-Malthusian concerns in their entirety, arguing that in spite of humanity's woes and worries about pollution and species loss, evolution is alive and well, and steadily delivering moving the world towards the next super-species. Of course, these sly responses both mask the inordinate degree of human suffering that must accompany the collapse of the current human population; just as the statistics on species extinction mask the inevitable suffering that has already occurred in the animal world.

The second response is to accept the broad conceptual and intellectual framework that exists – shot through as it is with the metaphor of struggle – but to search within it for strategies and behaviours that offer complementary or alternative modes of evolution. For example, it is abundantly clear that competition and struggle are not the only characteristics of biological and social systems. Cooperation, altruism, networking, symbiosis, mutual dependency also exist, and contribute in no small measure to the complexity and diversity of life. Case-Winters holds up the example of Lynn Margulis's ground-breaking work in symbiosis, claiming that it could provide an entirely different kind of metaphor for our relationship with nature than the one inherent in Darwinism:

> What if instead of imagining the way the world works as a struggle for existence waged by individual entities against their environments and in competition with other entities, we imagined it as an infinitely complex matrix of life in which communities cooperate both to adapt and to modify their environment? (Case-Winters 1997, p. 364)

Not dissimilar ideas are put forward in Norgaard's 'coevolutionary re-visioning of the future' (Norgaard 1994) and in Capra's *The Web of Life* (Capra 1997).

In spite of the promise which such ideas offer, it seems to me that they must be approached with some care as potential solutions to the impasse identified in this paper. One of the pitfalls into which they may lead us is the mistaken belief that they somehow obviate the need to account for the Malthusian element in nature. Perhaps it is true that modern science and social theory has over-emphasised the competitive elements of struggle. Perhaps it is true, as Roszak (1992) suggests that these aspects have become so heavily institutionalised in our science, because our science was largely the product of society in which competition and struggle were rife and that:

> Far from reading the ethos of the jungle into civilised society, Darwin read the ethos of industrial capitalism into the jungle, concluding that all life had to be what it had become in the early milltowns: a vicious 'struggle for existence'. (Roszak 1992, p. 153)

At the same time, to proceed in the blind hope that we can pluck harmony with nature from the ether, with no regard for the physical limitations apparent in the world, would be a recipe for disaster.

One possible variation on this response might be to accept, with Malthus, that suffering and evil are a necessary component in the order of things. Perhaps we should happily acknowledge their specific purpose in the grand design – namely to provoke us to (an ultimately futile) 'moral restraint' and lift us out of the mire towards a higher purpose. Unfortunately, within the confines of the evolutionary perspective, this option is singularly unattractive. As Morrison is keen to point out: there is no higher purpose. Moral restraint (indeed the whole idea of religion and god) is a purely evolutionary device, which shows no sign of curbing the patterns of excess to which humanity seems to be addicted. If it has any use at all, argues Morrison, it is as a super-specific evolutionary strategy designed to paralyse humanity in the face of impending disaster. Higher purpose, in the neo-Darwinian framework, is a pitiful consolation for the suffering that collapse would involve – or indeed for the suffering which already occurs.

A third avenue of response is to question the conceptual framework itself. This job is so hard, standing as we are within the confines of an entire worldview, that I could not hope to even begin it here. And yet, the existence of other attempts to question it should at least give us an indication that such a strategy is meaningful. I have already mentioned Martinez-Alier's dislike of the central Darwinist metaphor.[9] But he directs his attack at the metaphor itself, arguing that the 'dynamics of human history is better understood as the result of the struggle between rich and poor, the forms of which vary according to the changes in relations of production, than as a history of social organisms which 'adapt' to ecological conditions' (Martinez-Alier 1987, p. 11).

This argument is reminiscent of the Marxist critique of Malthus. The Marxists hated Malthus: they saw him as nothing more than an apologist for a capitalist regime founded on the exploitation and suffering of the working class. According to Malthus, this suffering was inevitable as a result of the scarcity of resources. Marxism therefore focuses its attention on deconstructing the idea of resource scarcity.

In an illuminating paper written twenty-five years ago, Harvey approaches the Marxist critique of Malthus through an anecdote concerning the reaction of a Chinese delegate to the Stockholm Conference on Environment and Development in 1972. To the bemusement of western observers, this delegate responded to concerns about resource scarcity with an emphatic declaration that in China there was no such thing. Harvey's interpretation of this remark is that it was not,

as the western observers might have thought, a statement about mineral reserves in China. Rather it was an indication of another worldview, an altogether different way of thinking about the question of resources. According to this interpretation what characterises the Malthusian approach to resources is its intrinsically Aristotelian attempt to conceptualise a resource as 'a thing in itself'. To Marx this notion is absurd: there is no such thing as a resource in the abstract or a resource that exists as a thing in itself:

> And it is of course the ability to depart from the Aristotelian view that gets Marx away from both the short run and long run inevitabilities of neo-Malthusian conclusions. Marx envisages the production of new categories and concepts, of new knowledge and understanding, through which the natural and social system will be mediated. (Harvey 1974, p. 327)

> Scarcity, according to this view, and all our notions of it are purely intellectual constructs which are 'necessary to the survival of the capitalist mode of production' and have to be carefully managed if the self-regulating aspect of the price mechanism is not to break down. (Harvey 1974, p. 329)

Interestingly, although the Marxists wanted to throw out Malthus, they loved Darwin, not least for the revolutionary impact of his theories on the established institution of the church. Ironically, of course, Marxism and its derivative communism have signally failed in the political struggle for survival which has characterised the history of the late twentieth century. The extent to which a Marxist worldview of 'Darwin without Malthus' could have offered a realistic escape-route from the impasse in this paper, is therefore difficult to assess. In spite of this, the Marxist critique does suggest the possibility of other, perhaps broader lines of attack on the underlying conceptual framework in which we are currently entrenched.

One of these lines of attack proceeds through a recognition that science and society are mutually intertwined. As Mirowski demonstrates in *More Heat than Light*, 'our claims to understand the physical world depend upon our social experience for justification and conversely … our theories of the social sphere are patterned upon our understanding of the physical world' (Mirowski 1989). The same message could be drawn from the exegesis in this paper. Modern sociology and philosophy of science now recognise the central role played by metaphor in constructing our worldviews.[10] Rorty (1979) stresses that 'it is pictures rather than propositions, metaphors rather than statements, which determine most of our philosophical convictions'. McFague argues further that our models of the world are all essentially 'metaphors with staying power' (McFague 1982), metaphors which have 'gained sufficient stability and scope so as to present a pattern for relatively comprehensive and coherent explanation' (McFague 1987).

Exactly such a model is the one provided by the metaphor of nature as a struggle for existence (Case-Winters 1997). Manier (1978) has gone so far as to suggest that Darwin's theory of natural selection could not have been expressed without the use of such a metaphor. What I have attempted to show in this paper is the extent to which this particular metaphor is embedded in the scientific theories with which we approach the world. From its roots in the Middle Ages to the literature of modern evolutionary psychology and genetics we are inextricably bound up in a quite particular notion of nature as struggle.

Thus, the suggestion implicit in the historical exegesis of scientific ideas is that there is an element of cultural contingency in the way we view the world, and our own position within it. Central to the world-view in which we currently operate is the Malthusian metaphor of struggle. Equally, however, it is clear that other cultures, in other times and places, have adopted very different views of the world, based on very different metaphors. It is therefore certainly not beyond the bounds of possibility that a cultural transition towards sustainable development might proceed, indeed might require us to proceed, from a different set of ideas, a different world-view, involving a new cosmology and a different metaphor.

Irrespective of this possibility, one thing is clear. Taken together, the longstanding metaphor of 'nature as a struggle' and the thoroughly modern theory of evolutionary psychology imply a substantial re-evaluation of traditional responses to the environmental crisis. Neither technological optimism nor wishful thinking about behavioural change will deliver us sustainability.

## NOTES

[1] The distinction between energy and available energy is an important one. Energy itself is in abundance. In fact, the first law of thermodynamics asserts that energy itself is neither created nor destroyed. But not all of this energy is available to perform useful work in the system. The importance of the second law of thermodynamics is the consequence that the general tendency is for energy through transformation to be become less and less available to perform useful work.

[2] See Chapter 2, 'The Apocalyptics', in Tom Athanasiou's *Slow Reckoning* for an extensive list of modern environmental warnings.

[3] For a detailed review of the literature and thought which flowed from the Georgescu-Roegen critique see Söllner 1997.

[4] The extent to which this later demand amounts to the same thing as the earlier one depends, of course, on the relationship between material throughput and economic growth. There is an argument to the effect that economic growth naturally drives improvement in the efficiency of use of material resources (e.g. Bernardini and Galli 1993), and that the best path towards sustainable development, is thus sustained economic growth (e.g. Beckerman 1996). However, as I have pointed out elsewhere (Jackson 1996; Jackson 2000), this argument is problematic at best, and at worst plainly unrepresentative of the path of economic progress today.

[5] See Jackson et al. 1993 for a more detailed discussion of these limitations.

[6] Excellent and generally thorough reviews of this literature may be found in Martinez-Alier's review of the roots of ecological economics (Martinez-Alier 1987), and in Hodgson's review of the evolutionary influences on economics (Hodgson 1993).
[7] For example, Spencer was vehemently opposed to any form of support for the poor or socially disadvantaged, largely because he believed that the 'survivors in social evolution merited their success and the losers deserved their fate' (Hawkins 1995).
[8] Perhaps the one exception to this is the position of Marxist thought on the matter. Since Malthus was largely seen as a reactionary, defending the interests of the property owners in a capitalist society, whereas Darwin was seen as an ideological precursor to Marxism, Marxist historians have always been keen to prise Darwinism from the Malthusian influence (see, for example, Harvey 1974).
[9] In fact, Martinez-Alier claims that his critique is of social Darwinism rather than Darwinism per se but to the extent that it is the metaphor itself he attacks, he is also attacking Darwinism. Besides, as Young (1985) points out: 'Darwinism is social'.
[10] See, for example, Black (1962) and chapter 2 in Hodgson (1993).

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