Dialectical Biology
A Marxist Approach to Nature and Agency in the Anthropocene Camilla Royle

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Dialectical Biology: A Marxist Approach to Nature and Agency in the Anthropocene

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The object of science: matter in motion, bodies. Bodies cannot be separated from motion, their forms and kinds can only be apprehended in motion; nothing can be said about bodies divorced from motion, divorced from all relation to other bodies.

Friedrich Engels, 1873.

What characterises the dialectical world, in all its aspects, as we have described it is that it is constantly in motion. Constants become variables, causes become effects, and systems develop, destroying the conditions that gave rise to them. Even elements that appear to be stable are in a dynamic equilibrium of forces that can suddenly become unbalanced, as when a dull grey lump of metal of a critical size becomes a fireball brighter than a thousand suns.

Levins and Lewontin, 1985, p279.
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Abstract
This thesis aims to assess how radical perspectives in biology might animate and inform political ecology.

In the 1970s and 1980s there were several social movements of politically engaged scientists active in various parts of the world, represented most prominently by Science for the People in the US. These scientists critiqued the uses to which scientific knowledge was being put but also its content. Therefore their activism called into question the supposed neutrality of science. Among them were a small group of biologists who, following Richard Levins and Richard Lewontin, tried to develop an approach to biological knowledge informed by Marxist dialectics.

The contribution of these biologists is addressed here in relation to two current theoretical debates around the relationship between society and nature and the role of the non-human in thinking about environmental issues. Firstly, new/vital materialist accounts of the more-than-human world are often opposed to ecological Marxism which is seen as being founded on a problematic nature-society binary and as insufficiently attentive to the materiality and agency of non-humans. Secondly (and related to the first) there is also a heated debate among Marxists on the question of nature. For example, there have been arguments between metabolic rift theorists and advocates of a world-ecology approach with the latter accusing the former of soft dualism and the former responding by defending an account of society and nature as a differentiated unity.

These controversies are playing out in the context of widespread discussions of the Anthropocene. The idea of an Anthropocene itself calls into question old certainties about society and nature, representing for some a recognition of the complex entanglements of human and non-human agencies, and for others an assertion of the overriding influence of humans on the biosphere.

In this thesis I argue that the dialectical approach developed within biology addresses many of the concerns of the new materialists. Far from neglecting the role of non-human agency, dialectical biologists have actually renewed discussions of this topic within their discipline, in particular with the concept of niche construction where it is argued that organisms ought to be seen as subjects as well as objects of evolutionary processes. It also points the way forward for a more ecologically informed Marxism.

This thesis is largely theoretical but it does draw on interviews with radical/Marxist biologists as well as some social scientists who have found the formers’ ideas relevant in their own work.
Introduction

There is no doubt that human activity is influencing Earth system processes in multiple and interconnected ways. Carbon dioxide concentrations in the atmosphere have recently exceeded the landmark figure of 400 parts per million meaning that the air we breathe contains around a third more carbon dioxide than our great grandparents breathed 100 years ago. Global temperatures are now more than 1 degree Celsius above pre-industrial levels and temperature rises are set to continue, raising the prospect of catastrophic and uncontrollable changes to Earth’s climate.

Climate change is not the only environmental issue of global concern. Air pollution remains a major global health risk, and antimicrobial resistance, threats to the oceans and displacement of people have been identified by the UN as emerging issues (UNEP, 2017). Since its invention at the start of the 20th century, plastic has become so common in the oceans that it poses a serious problem for human health and for biodiversity, with one study finding plastic in the bodies of a quarter of marine fish sampled (Gruber, 2015). The effects of human activity can also be observed in the bodies of living things themselves: humans are adapting the very DNA of non-human species, creating new forms of life such as the trademarked oncomouse made famous by Donna Haraway. Animals and plants are forming new assemblages as they move location to escape the rising temperatures or migrate into cities and encounter other species with which they have not previously been in contact (Marris, 2011). But, although human activity is creating both novel species and novel ecosystems, the number of new species created is a fraction of the number being pushed towards extinction by anthropogenic changes to the climate, habitat destruction and the human induced spread of disease (Dawson, 2016).

These multiple influences have ensured that the state of the biosphere has become one of the most pressing concerns of the 21st century and that it will likely increase in importance in terms of official policy and among activists. The effect human activity is having on the world is on such a scale that scientists are increasingly taking seriously the prospect that humanity has “entered a new geological epoch of its own making” (Castree, 2014, p436). Using the Greek word Anthropos (human), geologists propose to name this the “Anthropocene” to
signify an epoch when geological strata are dominated by artefacts of recent human origin. The Anthropocene idea has also been of public interest, taken up in the popular press (featuring on the front cover of *The Economist* in 2011 and highlighted by geographer Simon Lewis in the *Guardian*—Lewis, 2009) and has provided inspiration for works of art such as Jason DeCaire Taylor’s underwater sculpture “Anthropocene”.

The Anthropocene also provides an impetus to many of the debates taking place in contemporary environmental geography. “Geographies of the Anthropocene” was the theme of the high profile RGS (with IBG) Annual International Conference in 2015. Chaired by Sarah Whatmore, the conference attracted an audience of mostly human geographers but also included a keynote talk by Will Steffen formerly of the International Geosphere-Biosphere Programme and one of the scientists most closely associated with the idea of an Anthropocene epoch. Of course, society-nature theory has been an element of the discipline of geography since before contemporary discussions of the Anthropocene. As Noel Castree has argued (see Castree, 2000; 2005; 2014) geography itself, with roots in both the natural sciences and the social sciences, has tended to act as a “bridging discipline” with a particular, perhaps unique, ability to address questions of society and nature. Geography “has been centrally concerned with how humans and their environments relate to each other. Many of the most important disputes within the discipline can be traced back to different understandings of this relationship” (Loftus and Royle, 2017). The Anthropocene has, however, provided a “shock” to existing ideas about how publics might view the human place in the biosphere, what is meant by “nature” and how easily (or not) nature can be manipulated by human action (Lorimer, 2015, p3; Bonneuil and Fressoz, 2017).

In the context of increased discussions of, and public anxieties around, the role of human influence in the Earth system, this thesis will address how the perspectives of a group of Marxist thinkers from another discipline, biology, might animate and inform political ecology at this conjuncture. These biologists were actively involved in the radical political movements of the 1960s and 1970s around the uses of science and, crucially, they also saw Marxist ideas as relevant to debates within science. In particular the thesis focuses on a number of thinkers who have developed what they refer to as a dialectical biology (see especially Levins and Lewontin, 1985). In order to do this, it revisits a discussion of the concept of a “dialectics of nature” which, as will be demonstrated in chapter two, has proven controversial among Marxists in part due to the misguided approach to the application of dialectics to “nature” in the Soviet Union. However, the tragedy of Soviet biology doesn’t mean that “nature” should be outside the remit of Marxist philosophy. I argue that ecological Marxists have been integrating an understanding of biophysical approaches into their understanding since Marx and Engels’ own engagements with the work of natural scientists including Charles Darwin.
Therefore, this thesis also speaks to debates about whether Marxism could (or should) be developed in a more ecological direction. The potential contribution of Marxist biologists has been relatively overlooked within geographical thinking, particularly among advocates of what are described here as new or vital materialisms (see chapter three) whose ideas have dominated geographical discussions of the Anthropocene. However, for reasons to be discussed, many of these thinkers have been extremely dismissive of dialectical thinking. However, it is argued here that dialectical biology, far from being irrelevant to current debates, offers a resource for a critical rethinking of capitalist socio-natural relations.

1.1: Political ecologies
This thesis is primarily theoretical. It is concerned with ideas from biology and how they might be useful in shaping the way we think about environmental issues. However, according to Andreas Malm, an activist and scholar, theory can only take us so far. Malm asks whether we should be more concerned with the urgent and militant political action needed to slam the brakes on climate change (Malm, 2015 and 2018, p16). But, answering himself, he also argues that, as the present moment forces us to rethink the assumptions we have made about society and nature, theory itself is up for “re-evaluation”: “action remains best served by conceptual maps that mark out the colliding forces with some accuracy” (Malm, 2018, p16). This thesis aims to contribute in a small way to developing such a conceptual map.

Within geography, questions of socio-natural relations have often been raised under the banner of political ecology. Therefore, this subdiscipline of geography seems like a good place to start. Although political ecology itself is a broad and changing field, it is understood here as an attempt to politicise environmental processes by seeking to understand how power relations influence the relationship between human societies and the biophysical environment. Paul Robbins (2012) lists various definitions of political ecology, concluding that it is more aptly described as a “community of practice united around a certain kind of text” than as a “theory” (p20, emphasis in original; see also Walker, 1998, p132). Political ecology can be viewed as an alternative to apolitical ecologies such as the persistent assumption that the environment imposes “natural” limits on human populations. This position is itself implicitly political. However, it is often framed as an apolitical view and provides an apparently neutral, “natural” justification for concerns about population growth. By contrast, political ecologists recognise that when making any statement about the environment, politics is inescapable (Robbins, 2012, pp14-18). Early empirical work in political ecology often involved detailed studies of physical processes such as soil erosion and the ways in which these phenomena are driven by changes in human societies in particular, thereby relating processes at local scales with wider dynamics. It has traditionally been somewhat focused on rural or semi-rural human populations in the
developing world (Robbins uses an example from the east African savanna—Robbins, 2012, pp11-13) but it is by no means limited to these spaces and there is a vibrant sub-field of urban political ecology (Loftus, 2012; Heynen, 2014).

In their own discussion of political ecology, Blaikie and Brookfield criticise both social scientists who have tended to treat the environment as a “passive background to human interaction” (1987, p.xviii) and natural scientists who, they argue, have underestimated the extent to which the processes they measure are socially constructed (p.xix). They therefore define political ecology as an attempt to combine “the concerns of ecology and a broadly defined political economy” together encompassing “the constantly shifting dialectic between society and land-based resources” (1987, p17). The sub-field is also often informed by Marxist political economy—indeed, the opening article of the first issue of the Journal of Political Ecology (Greenberg and Park, 1994, p1) refers to Marx on the first page as the thinker who perhaps came closest to developing a materialist understanding of how societies and nature mutually transform each other and who therefore became a major influence on thinking within political ecology.

Although political ecologists take pride in their knowledge of the “concerns of ecology”, there has been some debate around the extent to which political ecology can (or should) call itself ecological. Peter Walker (2005) points out that, particularly from the 1990s onwards, the sub-field has become more concerned with environmental knowledges, representations of the environment and the politics of environmental social movements than with biophysical processes. The perceived neglect of the ecological within political ecology has led Walker to argue that it risks being marginalised within academic geography and that it “has diminished its capacity to contribute to solutions to environmental problems” (Walker, 2005, p77). Walker informs readers that, within the natural sciences, “ecology” has a specific definition: “the study of the interrelationships between living organisms and their physical environment” (Walker, 2005, p78). By contrast some political ecologists have used the word “ecology” in its popular sense, to signify a more general interest in the “natural” world or concern with broad environmental issues such as deforestation or land degradation. Likewise, Zimmerer alerts human geographers to a profound theoretical reorientation taking place among biologists and calls for them to take note of this shift. He points out that ecologists are moving away from the assumption that ecosystems tend towards stasis, arguing that many of these systems are characterised by flux and disequilibrium. Biologists have also started to address what Zimmerer refers to as the “subjectivity” of non-human organisms in terms of a discussion of their different behaviours and capacities to adapt to changing environments (Zimmerer, 1994). Interestingly, as we shall see in later chapters, similar conclusions have also been reached by those biologists influenced by Marxist philosophy.
1.2: Red-green politics redux

Political ecologists often apply their theoretical perspectives to real world environmental problems. Take for example, the debates in the 1980s and 1990s over forest conservation in the United States and the fate of the northern spotted owl. This classic environmental problem demonstrates the need for an understanding that is both dialectical and materialist. Any activist seeking a way forward through the tangle of disagreements surrounding an issue like spotted owl conservation would need ideological clarity as well as tact, understanding and commitment.

The northern spotted owl is one of three subspecies of spotted owl. Its range extends along the West coast of North America from Canada, through Washington State and Oregon as far as the north of California and it is closely associated with the coniferous forest of this part of the country. Ecologists researching the bird’s behaviour have reported that it prefers old growth forest which consists of a mix of older trees (often over 200 years old), as well as younger individuals and damaged or dead and rotting trees. The felled trees and undergrowth provide suitable nesting sites for owls and enable them to hunt prey species such as the flying squirrel. When the owls breed, their young disperse themselves widely, suggesting that they need large areas of forest in order to breed successfully (Ackers et al, 2015; Birdlife International, 2013; Royle, 2017a).

The northern spotted owl population is decreasing with logging for commercial timber production being the major (though not the only) reason for the decline (Birdlife International, 2013). Furthermore, the owl is often treated as an indicator species, providing a symptom of the state of the forest in general. Since the early 1980s, when the Reagan government proposed full conversion of the forest to managed timber plantations, the owl and the habitat it lives in have been the subject of a heated conflict between the forestry industry and wildlife conservation groups. Following public opposition to this plan, various proposals to protect areas of forest were put forward. The Northwest Forest Plan, approved in 1994, would set aside 5 million acres of forest. But it was predicted that this would lead to 28,000 job losses in the timber industry causing widespread anxiety among timber workers and their families. Some forestry workers protested by displaying bumper stickers with the slogan “I like spotted owls—frienemy” and dead owls were allegedly found nailed to road signs (Foster, 2002, p119).

The plan also failed to satisfy environmentalists. The Native Forest Council continued to oppose all resource extraction of any kind on public land and organisations such as radical green group Earth First! took direct action to try to stop the felling of trees (Foster, 2002).

Marxist Sociologist John Bellamy Foster, in a wide-ranging analysis of the economics and politics of the timber industry on the West coast, points out that jobs were being lost in any case as a result of various factors including mechanisation in the timber industry and reduced
demand for timber in housing. He argues that, in the absence of effective solidarity between workers and environmentalists, the forestry industry saw an opportunity to redirect the blame onto environmentalists. The industry supported the Wise Use Movement, which promoted logging and lobbied against environmental legislation, thereby attracting the support of some workers: “It is no secret that the Wise Use Movement is bankrolled by corporations… Nevertheless [it] has a grassroots basis” (Foster, 2002, p127). The movement seems to have been effective in convincing some that wildlife would continue to thrive if old growth forest was replaced by plantations—in spite of the statements to the contrary from ecological scientists. One timber worker in a public hearing in 1989 expresses this understanding, saying: “Unless a person has actually sat quietly at a logging site and watched and listened, they cannot appreciate the amount of wildlife that is around” (Proctor, 1996, pp270-271). So Wise Use propagated an ideal of a productive, managed, ordered environment in contrast to the messy forest full of rotting wood favoured by spotted owls.

The case of the northern spotted owl cannot be understood without reference to the political forces involved; what happens to the trees in the forest and the owls that live there is inseparable from human action. This human agency operates at multiple scales, from the local disputes between workers, unions, environmental groups and logging companies to the level of national policy and global markets for timber. Of course, the forest is not a “wilderness”, it has been influenced by human action for some time. Even before the logging companies arrived, the forest was inhabited by people including First Nations communities, whose activities shaped it.

The northern spotted owl case also involves issues of representation, and poses questions such as: how is the forest described by different actors in, for example, magazine articles, websites, government reports, contributions to public meetings? Who are these representations aimed at and what purpose do they serve? How do people who have never visited these forests or seen a northern spotted owl build up an idea of what the forest and its animal inhabitants are like? Therefore, the forest itself can be seen as a social artefact “constructed” by the various human-driven processes involved: it is constructed in the sense of being physically manipulated by humans and in the sense of figuring in cultural representations and these types of construction mutually reinforce each other (Braun, 2002).

But, at the same time as the forest is constructed by humans, the behaviour of the owls themselves also plays a role. Although many species of animal have adapted to the transformations humans have made to their environments, these birds have not coped well with changes to their habitat. Whether humans like it or not they seem to have a real preference for old growth forest and to actively choose it. Therefore, there are material attributes of the owls that seem to defy being completely absorbed within human processes. This contradiction,
between the construction of the biosphere and the role of non-humans such as animals within it, frames many of the debates this thesis engages with.

Hobson (2007) offers an intriguing response to this problem. She argues that non-humans should be seen as active subjects in socio-environmental processes, rather than as passive bystanders. When animals are objects rather than subjects, they can end up being viewed as “co-oppressors of the world’s marginalised and poor” (p253). Indeed, the Oregon forest workers who nailed owls to road signs certainly seem to have viewed the animals as complicit in their oppression. According to Hobson, rather than simply taking the side of the humans in this conflict, political ecologists ought to refuse to accept the terms of a debate that pits humans and animals against each other. Likewise, Foster also refuses to take sides, calling for a wider critique of the capitalist economic system that simultaneously exploits workers and degrades the biosphere (Foster, 2002, p131).

The northern spotted owl example also raises the question of the kind of knowledges needed to make sense of these ecological debates. Although insights from the human sciences such as sociology and economics are needed in order to grasp what is happening in the forests, it cannot be understood purely with reference to human activity. Therefore, Richard York, who is based in Oregon and was influenced early in his career by debates over West coast forest conservation, explains why an integrated understanding of both human processes and the natural sciences is needed. He mentions the work of the dialectical biologists, with which this thesis engages, as an example of such an approach:

> It’s a social problem. The problem isn’t just about the owls…it’s human activity, it’s human economy, it’s human behaviour. If you want to solve environmental problems it’s a social change question… If you want to understand humans and the environment you really need a bigger picture understanding of ecological sciences and the social sciences. Most social scientists really don’t engage with the natural scientists very much and a lot of the natural scientists are often very naïve about social science and don’t understand the political processes. This is one of the reasons why I think the dialectical biologists have a more sophisticated view of politics and society (interview, 19 April 2017).

The northern spotted owl provides a classic case of an environmental problem about which much has been written. As a “jobs versus the environment” issue it has become particularly polarised. But it is not the only case of an environmental problem that brings together a diverse set of human and non-human factors. Debates over whether to adopt land-sparing agricultural practices to provide “more space for wildlife” or over the currently high-profile issue of plastic
pollution in the oceans similarly bind together the actions of humans and those of non-human living things. These issues provoke us to consider our definitions of society and nature, how to conceptualise the relationship between the two (or whether to reject such terminology as in itself founded on a dualism) and who or what we consider as agents in such an analysis.

This thesis therefore considers the contribution of Marxist biology to these questions. But issues of ecology and the environment were not always considered priorities for Marxists in the 20th century. In a striking commentary on his own intellectual heritage, Ted Benton, a sociologist and practicing field ecologist, explains how he didn’t always see the connection between his interest in wildlife and his political commitments:

The link between Marxism and nature is something that would be hardly conceivable for people on the left in my youth… There has been a huge transformation in the way that we think about these things. I want to say a bit about that because I think it throws some light on where we are now.

When I was a teenager in the 1950s in Doncaster in South Yorkshire I was living in a big working-class estate with a massive presence of heavy industry and mining. The working class had an immense power… I was drawn into that. But at the same time, like quite a few boys—specifically boys (the gender issue is quite significant)—of my age, we were essentially feral kids. We actually roamed the quarries and the river banks and the marshes and the very lightly grazed pastures and so on that were interspersed in the industrial landscape. We started collecting birds’ eggs and local flowers and butterflies and had tadpoles and watched them grow into frogs and so on.

That to me was a very important part of my childhood. It gave a lot of meaning to me as a kid. But I never saw any connection whatsoever between the class politics that was very prominent at that time and these other interests.

In the early 1970s when I was…lecturing in sociology at Essex University I gave quite a lot of lectures on Marx and Marxist philosophy and was involved to some extent in supporting student occupations and lecturers’ strikes and stuff like that… At the same time, I actually wrote articles on campus wildlife… One of my ex-students came up to me [at a reunion] and said: “We all thought this was great to have this lefty lecturer talking about Marx but then we realised you were writing about flowers and
butterflies and we were totally disillusioned and horrified” (Benton, 2016).

Benton goes on to explain how he himself didn’t see the connections between his work in sociology and environmental issues until the emerging green movement started to raise the issue of the link between social relations and what was happening to the rest of nature. But these movements developed quite autonomously from the socialist left and often antagonistically towards it (Benton, 2016). As the northern spotted owl example demonstrates, environmental concerns have sometimes been pitted against workers’ demands for jobs and better living conditions. Likewise, in the 20th century, Marxist ideas weren’t necessarily appealing to environmental activists and there was some debate as to whether Marxism is relevant to environmental concerns (Harribey, 2008; Benton, 1981).

In May 1917, the Polish born revolutionary Rosa Luxemburg, in a letter to her friend Sophie Liebknecht, describes her interest in wildlife and expresses the tension between this interest and the concern with relationships between humans that might seem more central to socialist enquiry. She even suggests that this fascination with animals might be considered “treason to socialism” if her comrades found out about it:

You ask what I am reading. Natural science for the most part; I am studying the distribution of plants and animals.

Yesterday I was reading about the reasons for the disappearance of song birds in Germany. The spread of scientific forestry, horticulture and agriculture, have cut them off from their nesting places and their food supply. More and more, with modern methods, we are doing away with hollow trees, waste lands, brushwood, fallen leaves. I felt sore at heart. I was not thinking so much about the loss of pleasure for human beings, but I was so much distressed at the idea of the stealthy and inexorable destruction of these defenceless little creatures, that the tears came into my eyes…

I suppose I must be out of sorts to feel everything so deeply. Sometimes, however, it seems to me that I am not really a human being at all but like a bird or a beast in human form. I feel so much more at home even in a scrap of garden like the one here, and still more in the meadows when the grass is humming with bees than—at one of our party congresses. I can say that to you, for you will not promptly suspect me of treason to socialism! You know that I really hope to die at my post, in a street fight or in prison.
But my innermost personality belongs more to my tomtits than to the comrades. This is not because, like so many spiritually bankrupt politicians, I seek refuge and find repose in nature. Far from it, in nature at every turn I see so much cruelty that I suffer greatly (Luxemburg, 1917).1

Evidently from this letter, the removal of habitat for birds by clearing dead wood from forests in the cause of “scientific forestry” was a source of concern long before the northern spotted owl debates of the 1980s and 1990s. Luxemburg’s reference to dying in prison is also prescient given that she would be imprisoned and killed not long after these words were written. Of more direct relevance to this thesis, Luxemburg also captures something of the contradiction between approaches that try to grasp something about the intrinsic characteristics of non-humans and those that treat non-humans in terms of their relationship with humans, for example as a source of pleasure.

1.3: Marxism, materialism and biology

In the years since the debates over northern spotted owl conservation, theoretical struggles over interpretations of nature-society theory within geography have continued. This thesis will address in particular the emergence of a strand of theory that might be referred to as new or vital materialism and which aims to address the apparent omissions in ecological Marxism. This “diverse and increasingly well known” body of literature has come to dominate discussions of society and nature (Braun, 2015, pp1-2). As will be explained further in chapter three, this work often involves an interest in the materiality of the non-human world, a rejection of dualist approaches to nature and society and a preference for referring to socio-natural hybrids. New materialists have developed novel understandings of the agency of non-humans and its adherents have referred to the vitality and inventiveness of natural processes (Braun, 2008). These thinkers have a particular interest in knowledges from the natural sciences and how these might provide a way of addressing the perceived lack of regard for non-human processes in political ecological accounts. For example, Bennett (2010) and Grosz (2011) both make use of a reading of Darwin’s work, while Barad draws on ideas from theoretical physics (Barad, 2007).

Ecological Marxism, on the other hand, is centrally concerned with the influence of the development of capitalism on socio-natural systems. As will be argued in chapter two, the dialectical and materialist approach of Marx and Engels has been a continual point of reference for ecological Marxists. For example, a discussion of dialectics, understood as an emphasis on

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1 Thanks to Kamren Nayeri for making me aware of this letter.
the processes that constitute things rather than the things themselves, forms a chapter of David Harvey’s (1996) book *Justice, Nature and the Geography of Difference*. However, some new materialist thinkers have been suspicious of Marxist approaches and of dialectics. Perhaps influenced by Bruno Latour’s contention that Marxism has done little to overcome dualist accounts of society and nature, retaining a “notion of society and nature as a pair” (quoted in Malm, 2018, p58), they have criticised such thinking on the grounds that, they say, it imposes a type of binary thinking whereby society and nature are two separate realms that come to relate to each other. Latourian thinkers have also argued that dialectics is unable to account for the agency or materiality of non-human forces (see Lorimer, 2013). Marxism is, therefore, seen as limited in its ability to address the questions raised by the Anthropocene where human influence seems to have become inextricably entangled with biospheric processes. However, some counter that this scepticism about dialectics is overblown and that dialectical and new materialist approaches actually share much in common (see Sheppard, 2008 for example).

Alongside this muted standoff there have also been debates among Marxists around different understandings of nature and society. This is represented strikingly by the recent feud between metabolic rift theorists including Andreas Malm and John Bellamy Foster on the one side and world-ecologists such as Jason W Moore on the other (Foster, 2016b and 2016c; Moore, 2017b) but there have been sharp differences for some time now, for example Foster is also critical of David Harvey and of Neil Smith’s earlier writings on the production of nature. These debates will be addressed further in chapter two. Here, suffice it to say that there are important debates about how Marxists might conceptualise capitalist societies’ treatment of nature including whether capitalism can be said to create a rift in the society-nature relationship, and around the possible contribution of non-humans to value. So, there are two debates at work, one between people who are sceptical that dialectical methods are a useful element of society-nature theory and another between Marxists, many of whom refer to their conceptions as dialectical but have differing interpretations of what that might mean. For the latter, elaborating a dialectics of nature has become a central question. These two debates are interlinked. For example, Malm has strongly criticised Moore because, as he sees it, Moore flies too close to the new materialist, hybridist, Latourian trend in contemporary theory (by contrast Malm refers to his own project as an effort to “capture a dialectics of society and nature”—Malm, 2018, p59, emphasis added).

An analysis of the work of dialectical biologists speaks to both of these debates. It addresses some of the criticisms levelled against dialectics by highlighting a tradition of thought concerned with complexity, dynamism and agency, concerns that might generally be associated with new materialist thought. It also adds clarity to the debates among Marxists by demonstrating what a dialectical approach to the “natural” world might look like in practice.
But there are also issues at stake when social scientists look to biology for answers. As Bruce Braun points out, geographers, including many within the new materialist tradition, are engaging with biological knowledges. This is to be welcomed as “not only justifiable but also necessary” for those who reject dualistic views of society and nature (Braun, 2015, p3). J Anthony Stallins agrees that “maintaining an awareness of current biological and evolutionary thought should be considered essential for any discipline [ie geography] that studies the human-environment relationship” (Stallins, 2012, p438). Commenting on this interest in biology, sociologist Nikolas Rose has gone as far as to state that the social sciences are entering a “biological age” in which a new relationship between the human and biological sciences is required (Rose, 2013). In geography this interest in biology has started to manifest itself in the last few years. For example, Myra Hird, in collaboration with the influential biologist Lyn Margulies, has argued that theories of symbiosis have the potential to complicate accepted notions of the separation of nature and culture (Hird, 2010). Furthermore, in the last few years, animal geographers have also produced a wealth of critical engagements with the lives and histories of animals (Emel, Wilbert and Wolch, 2002, see also chapter three here).

Benton also argues for a reengagement on the part of social scientists with biology. But he cautions that such an approach should avoid reductionism (Benton, 1991). If reductionism within the “natural” sciences tends towards seeing biology as essentially explainable with recourse to physics (see also chapter five), its logical correlate is that psychology, anthropology and, ultimately, the social sciences fit into this hierarchy and can be similarly reduced to biology. Meloni (2014) further criticises a tendency to treat biological knowledge as ontologically prior to the social; biology can be seen as a “solid foundation” on which human society is built. But such an approach would be unhelpful for developing a critical political ecology. We should avoid biologism, the inappropriate application of biological ideas to attempt to explain social phenomena.

Meloni also questions the tendency of some social scientists to see biology as essential unified and therefore to neglect major disputes within the field. Likewise, for Braun, there is a persistent assumption in some of the literature that science “speaks in one voice” leading to a neglect of sharp theoretical differences among natural scientists (Braun, 2015). Nevertheless, Benton (1991) sees good reason for social scientists to engage critically with biology and, indeed, to take a position on debates within the discipline. In particular, he refers to the work of dialectical biologist Richard Lewontin as an example of non-reductionist biology that sociologists might learn from. If such an engagement recognises that biology itself is already a

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2 Nikolas Rose is the younger brother of Steven Rose, a British Marxist neuroscientist also referred to in this thesis.
site of contestation, it should, therefore, be possible to critique its ideas. Indeed, many biologists are themselves already involved in intense debates within their own discipline.

1.4: Structure of the thesis

The following chapter of this thesis will review the major trends within ecological Marxism including some of the aforementioned debates that have developed among Marxists. As a major theme throughout the thesis is the need for a dialectical approach, this chapter introduces the subject of dialectics and shows how some thinkers within geography have used dialectical methods in their work. The dialectical biologists make a clear argument that such a methodology can be useful in understanding the non-human world as well as human societies. But any attempt to argue this position must also acknowledge the troubled history of arguments for a “dialectics of nature”, an idea most associated with Marx’s collaborator Friedrich Engels. This chapter shows why some theorists have been sceptical about the notion of a dialectics of nature, in particular it addresses the contention of the Hungarian Marxist Georg Lukács, who at times argued that Engels was fundamentally wrong in his application of dialectical thinking to “nature”, but whose ideas have also been met with their own critique.

As discussed above, the notion of an Anthropocene epoch provides context to the lively debates on society and nature currently taking place. Therefore, chapter three opens with a discussion of this popular concept, explaining some of the controversies around the diagnosis of the Anthropocene and the wider theoretical issues it raises. The chapter goes on to address a body of work, collectively referred to here as “new/vital materialisms”, which has emerged in recent years and which calls for a renewed engagement with the liveliness or vitality of non-human matter. Arguably new materialists have been more prepared to engage with the Anthropocene than some Marxists who have been sceptical about the proposals for a new epoch. However, the chapter also assesses some of the criticisms that have in turn been raised against the new materialist project.

After a brief chapter (four) explaining the methods used to gather and interpret interview data for this thesis, chapter five—the first of three more analytical chapters—addresses the contribution of the dialectical biologists. The chapter draws on interview-based research as well as a study of these scientists’ written work. As explained here, many of the biologists interviewed were part of the campaign group “Science for the People” and combined political activism with their research. They navigated the contradictions inherent in doing scientific work that was both politically engaged but still aimed at finding out truths about the world. This chapter shows how this small group of biologists have made use of dialectics, with a particular focus on the themes of dynamism and complexity evident in their work. The chapter
responds to some of the criticisms levelled at Marxism by the new materialists by pointing to a
dialectical approach that is very much concerned with the materiality and agency of the non-
human.

Chapter six extends what, for many, is the key contribution of dialectical biology, its notion of
the organism as a subject as well as an object in evolution. From within their own discipline,
the dialectical biologists have theorised the specific ways in which non-human organisms can
be said to exhibit agency. In particular Levins and Lewontin and their various associates have
argued that organisms actively construct their environments as well as being influenced by
those environments (see Levins and Lewontin, 1985). This insight is explicitly influenced by
Marxist philosophy, with its own concerns with the ways in which humans act to change the
world around them and at the same time change their own nature. The chapter demonstrates
how this idea has been taken up within biology, in particular how it has enlivened
contemporary debates around the concept of the biological niche (Odling-Smee, Laland and
Feldman, 2003). The dialectical biologists’ relevance for political ecology is both
methodological and substantial. Therefore, this chapter turns to the question of what political
ecology might look like if it incorporated the ideas developed within biology. It shows how
dialectical biology offers a non-dualist perspective on ecology with particular attention to
novel or human-created ecosystems. The aims here are therefore twofold: engagement by
political ecologists with a set of overlooked ideas from the natural sciences as well as a
contribution to more philosophical debates about what it means to adopt a dialectics of nature.

Chapter seven demonstrates how one way in which this thinking might be taken forward in
developing a more historical political ecology. This question has been raised by animal
geographers in response to the human exceptionalism that, some argue, treats only humans as
historical actors and denies the capacity of non-humans to participate in historical change—
exceptionalism that has been evident in some discussions of the Anthropocene (Wilcox and
Rutherford, 2018). As well as ideas within contemporary biology from the previous chapters,
this chapter also builds on a discussion of the ways in which animals are represented in natural
history museums and in Darwin’s writings on the small agencies of earthworms which offers
an alternative historical approach to animals. The chapter continues by addressing the
contributions of dialectical biology to issues of human evolution and human “nature”. The
final chapter concludes the thesis by summarising the key points made in the preceding
chapters and offering an argument for a political ecology informed by dialectical biology.

Much of the work informing this thesis has been published. The overall structure of the
argument is based on an article, “Complexity, Dynamism, and Agency: How Can Dialectical
Biology Inform Geography?” published in Antipode in May 2017 (Royle, 2017b). Here I
reviewed the literature on dialectics in geography and the new/vital materialisms. I explained
why there is a debate between followers of these two approaches before going on to discuss the work of biologists Richard Levins, Richard Lewontin, Ivette Perfecto and John Vandermeer. This article demonstrated how these thinkers’ ideas counter some of the criticisms levelled against dialectical thought and the ways in which they might inform political ecology. I received very positive and encouraging feedback on this article from Richard Lewontin (by email).

The review of ecological Marxism in chapter two is an expanded version of a short book chapter I was asked to write for a forthcoming Handbook of Marxism and Post-Marxism, published by Routledge and edited by Alex Callinicos, Lucia Pradella and Stathis Kouvelakis (Royle, forthcoming). This also builds on the argument in an article in International Socialism entitled “Dialectics, Nature and the Dialectics of Nature” (Royle, 2014a). This article debated the issue of a dialectics of nature and argued that to talk of a dialectics of nature requires a discussion of what we mean by “nature” as well as dialectics. In addition, part of chapter three is based on an article on the Anthropocene published in International Socialism (Royle, 2016b). This introduced the idea of the Anthropocene to a general audience and explained some of the debates around the concept. The article was used on the reading list for an undergraduate and postgraduate course in environmental sociology at Virginia Commonwealth University in the US. Chapter seven is an extended version of another book chapter titled: “Shaking the Ground: Histories of Earthworms from Darwin to Niche Construction” in an edited collection, Historical Animal Geographies, published by Routledge in 2018 (Royle, 2018).

An entry I co-wrote with Alex Loftus for the Oxford Bibliographies series on Nature/Society Theory helped clarify my ideas on different approaches to the issue of “nature” and “society” within geography and provides some of the references for this thesis (Loftus and Royle, 2017).³ I also published a short peer reviewed entry on the northern spotted owl for an encyclopaedia of animal geographies, Humans and Animals: A Geography of Coexistence which encouraged me to revisit this classic case study of a controversy around species conservation (Royle, 2017a). Books I have reviewed that are referred to in this thesis include Jamie Lorimer’s (2015) book Wildlife in the Anthropocene (reviewed in Human Geography, Royle, 2016a), John Parrington’s (2015) The Deeper Genome (reviewed in Monthly Review, Royle, 2016c), This Changes Everything by Naomi Klein (Klein, 2015, see Royle, 2015) and the 2014 Haymarket edition of Paul Burkett’s Marx and Nature (Royle, 2014b).

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³ The Oxford Bibliographies are peer-reviewed bibliographies providing a list of references on a particular topic with annotations and introductory explanations of the sources.
I am also thankful to have been given the opportunity to present my research in sessions at the RGS (IBG) Annual Conference, The Association of American Geographers Annual Conference, Historical Materialism Conference, the London Conference in Critical Thought, the Political Ecologies of Conflict, Capitalism and Contestation (PE-3C) International Conference, a conference titled “Performing Dialectics” at Queen Mary, University of London in 2015 and the Oxford Real Farming Conference in 2017. I discussed my work at the King’s Climate Exchange and at various paper presentations and reading groups within the Department of Geography at King’s.

1.5: A note on vocabulary
Words such as “nature” and the “environment” used in this thesis have often been problematised in discussions of the biosphere. The language we use structures our understanding of the world and it is sometimes difficult to avoid using words that are laden with different meanings. Although many of us have an intuitive sense of what is meant by “nature”, Raymond Williams described it as “perhaps the most complex word in the English language” (Williams, 1976, p219). “Nature” tends to evoke a realm separate from human influence, which many of the authors discussed in this thesis would say simply does not exist. Therefore, where possible I have tried to avoid using the word except critically.

Similarly, the “environment” also refers to something that “doesn’t exist”. On one level the word simply means “surroundings” and can be used to refer to the material and organic conditions that organisms live within and relate to, rather than as something that simply exists “out there”. However, it is possible to criticise even this relational view. Therefore, following the radical agricultural theorist Colin Tudge, I have preferentially used the word “biosphere” to refer to the part of the world inhabited by living things. “Environmentalism” also refers to various social movements and their associated ideas, so I have referred to environmentalism, environmental movements, environmental geography and environmental issues for want of better words to describe these.

In biology, “ecology” is a branch of the discipline concerned with analysing the relationships between living things and with the non-living elements of the biosphere. As this suggests a relational perspective it avoids some of the more problematic connotations of “nature” as separate from society. Therefore, I have referred to ecological Marxism and where particular thinkers describe themselves as ecosocialists I have adopted this terminology.

Finally, the term “environmental crisis” has been criticised by some. The identification of a crisis too easily allows for some to pose the kind of post-political solutions discussed here in chapter three (see Swyngedouw, 2018). Therefore, without wishing to minimise the real threat
posed by problems such as climate change to people’s lives and welfare (particularly in the Global South), I have tried to avoid calling this a “crisis”.
Chapter 2: Ecological Marxism

The previous chapter referred to Benton’s comments on how his interest in wildlife developed somewhat separately from his socialist politics. However, in the past few decades there has been a growing interest in questions of ecology and climatic instability among Marxists. For these thinkers, Marx’s method, his historical materialism and dialectics, is as important as his substantive conclusions in *Capital* (Holleman, 2015).

This chapter starts by outlining Marx and Engels’ approach to questions of science and ecology and continues with a discussion of the work of those Marxists who continue this project today. These include the early attempts of James O’Connor, Benton and others to reconcile Marxian ideas with those of the environmental social movements of the 1960s, the “second stage” ecosocialism that developed in response to these attempts, the production of nature approach, associated primarily with Neil Smith, and the world-ecology of Jason Moore and colleagues.\(^4\) As this chapter will show, a (sometimes heated) dispute has arisen between followers of these different approaches as to the type of theory needed to make sense of socio-natural relations. For example, Moore has been particularly critical of interpretations of a theory of metabolic rift associated with the second stage ecosocialists. The former have in turn criticised Moore’s approach which they see as a departure from Marx’s own method.

One aspect of this debate that is not always raised is that several of its interlocutors have invoked the work of the dialectical biologists. The current schism between ecological Marxists is rooted in discussions of what constitutes a Marxist philosophy, but also more specifically in older debates about what a dialectical approach to nature consists of. Therefore, this chapter introduces the subject of dialectics with a particular focus on Engels’ unfinished project of developing a “dialectics of nature” and the subsequent debates this has provoked. For this the work of the dialectical biologists is informative as it offers one of the few attempts to actually elaborate a dialectical approach to nature and show what such an approach might look like in

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\(^4\) No doubt the overview here will contain many omissions, notably this chapter focuses on the work of North American and European writers with which I am most familiar.
practice (as Jason Moore argues, it is often easier to invoke dialectics than to demonstrate it—Moore, 2017b, p304).

2.1: Marx and Engels on the question of nature

In *The German Ideology*, Marx and Engels jointly state that: “The first premise of all human history is, of course, the existence of living human individuals. Thus, the first fact to be established is the physical organisation of these individuals and their consequent relation to the rest of nature” (Marx and Engels, 1968 [1845-6]). In the *Economic and Philosophical Manuscripts* (of 1844) Marx takes an even more apparently naturalistic stance, writing: “Nature is man’s inorganic body… Man lives from nature—ie nature is his body—and he must maintain a continuing dialogue with it if he is not to die. To say that man’s physical and mental life is linked to nature simply means that nature is linked to itself, for man is a part of nature” (Marx, 1959 [1844]). These references to “nature” in two key early statements of their theoretical approach show that Marx and Engels made relations with the rest of nature central to their understanding.

The notion of nature as the “inorganic body” of a human suggests a holistic approach whereby humans are a part of nature and nature is a part of human life in the form of the human body. Marx and Engels evidently saw socio-natural relations as a starting point for building an analysis of capitalism rather than something added to the analysis after the fact. Indeed, Marx distinguished his thought from that of the political economists he critiqued in that he saw wealth as a product of the activities of labour and nature, whereas for the political economists, wealth or use value derives only from human activities, a viewpoint that itself reflects the alienation of humans from nature. Kohei Saito goes as far as to argue convincingly that “it is not possible to comprehend the full scope of [Marx’s] critique of political economy if one ignores its ecological dimension” (Saito, 2017, p14).

Marx continues his discussion in the *Manuscripts* by elaborating how humans produce various material products through their labour. At this point he establishes a dialectic between human subjects and their object (Smith, 2008, pp32-35). The ability to produce *consciously*, a human’s “species being”, in Marx’s terminology, differentiates humans from animals: “The animal is immediately one with its life activity. It does not distinguish itself from it. It is its life activity. Man makes his life activity itself the object of his will and of his consciousness” (Marx, 1959).

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5 This statement is meant to refer to all humans, not just men. Indeed, Marx often used gender neutral German terms which were later translated into English as words like “man”.

6 Marx’s views on nature are, of course, the subject of several book length studies that can elaborate them in much more depth than is possible here (see Foster, 2000, Burkett, 2014, Saito, 2017 for example).
In volume one of *Capital* Marx adds a further point that humans relate to nature by exercising labour power as they appropriate the “materials of nature”:

> Labour is, first of all, a process between man and nature, a process by which man, through his own actions, mediates, regulates and *controls the metabolism between himself and nature*… He sets in motion the natural forces which belong to his own body, his arms, legs, head and hands, in order to appropriate the materials of nature in a form adapted to his own needs. Through this movement he acts upon external nature and changes it, and in this way, he simultaneously changes his own nature (Marx, 1976 [1867], p283, emphasis added).

In the same chapter, Marx outlines an understanding of the labour process in general, in which both humans and nature participate, and again makes a distinction between humans and other animals on the basis of conscious planning by humans:

> A spider conducts operations which resemble those of a weaver, and a bee would put many a human architect to shame by the construction of its honeycomb cells. But what distinguishes the worst architect from the best of bees is that the architect builds the cell in his mind before he constructs it in wax (Marx, 1976, p284).

Here humans “confront” nature as they work, and simultaneously change themselves, acting upon external nature rather than *simply* being part of nature (Marx, 1976, p283). So, taking the quotes together shows that Marx took the apparently contradictory position that humans are “part of nature” but are able actively to differentiate ourselves from the rest of nature. This is not the type of holistic approach that simply treats society and nature as indistinguishable; it is one whereby socio-natures are treated as a *differentiated* unity (see the discussion in Henderson, 2009, pp266-270). David Harvey similarly notes the “complexity” of Marx’s dual conception of the human-environment relation, pointing out that, for Marx, humans are described as part of nature and “at another level” as “an ensemble of social relations” (Harvey, 1974, p266).

Marx’s initial general statements on “the labour process independently of any specific social formation” (Marx, 1976, p283) lay the groundwork for thinking about how human beings relate to the rest of the biosphere. But, of course, Marx and Engels were concerned not just with human labour in general but with humans organised in different types of society. Ecological Marxism therefore develops a critique of the specific ways in which capitalism—defined by exploitation of human labour power driven by competition between capitals in order to accumulate greater profits—propels ecological destruction. In contrast to liberal
approaches that treat humans as atomised individuals, for Marxists, humans are social beings. The human relationship with the rest of the biosphere is intrinsically related to the way in which the production process is organised (see White, Gareau and Rudy, 2017, p26). This is why Harvey can say that: “All critical examinations of the [human] relation to nature are simultaneously critical examinations of society” (Harvey, 1996, p174).

For Marx, the ability of humans to perform labour has historically become alienated with the development of societies divided by class, and further so with capitalism. When humans are compelled to produce what will make a profit for the capitalist and no longer own the products of their labour or control the labour process, this leads to a form of alienation from their species being: “estranged labour tears from [the human] his species-life”. Therefore, as Saito has argued, Marx’s understanding of nature must be understood with reference to his writings on alienation. Modern labourers “can no longer relate to nature as their own ‘inorganic body’… When the land becomes a commodity, the relationship between humans and land is radically modified and reorganised for the sake of producing capitalist wealth” (Saito, 2017, p41).

Rather than being naturalised, capitalism is, for Marxists, understood as a transient phenomenon. As Saito (2017, pp59-60) explains, Marx differs from his predecessor Ludwig Feuerbach in that, for the latter, nature tends to be treated as ahistorical, whereas for Marx it is necessary to explain the specific origins of capitalist socio-natural relations (Hollemman, 2017, p168). Rather than treating “man” and “nature” as abstract entities, they must be seen in their concrete specificity, to account for “the historical process of the formation of nature through the human activity of production” where history itself is understood as mediated by human labour (Saito, 2017, pp58-61). Nature, in this account, is itself historical because it cannot be understood as distinct from human activity.

In this spirit, Marxists have thrown light on how human-environment relations have changed throughout history. Martin Empson’s book Land and Labour (2014) uses several examples to demonstrate the lasting effects past humans have had on the landscape and how, for example, a qualitative shift from feudal to capitalist production relations had a profound effect on the way agriculture is organised. Naomi Klein (2015) further demonstrates the destructive effect of specifically capitalist social relations, turning her attention to the contemporary fossil fuel industry. Klein shows how fossil fuel extractors are driven by competition to accumulate and must continuously expand their operations, prospecting for further sources of oil and gas and in many cases exploring ever more “extreme” fuel sources such as oil from tar sands (Klein, 2015). Ecological Marxists have, of course, also envisioned a future society where a more rational approach to the biosphere will correspond with more democratic and egalitarian social relations.
Marx himself also pointed to qualitatively different ways of relating to the biosphere inherent to different ways of organising society. He criticised thinkers like the demographer and political economist Thomas Malthus, for whom the laws of capitalist production are treated as eternal “natural laws”. By contrast Marx posited that: “every particular historical mode of production has its own special laws of population, which are historically valid within that particular sphere” (Marx, 1976, p784). In other words, Marx saw the unemployment and poverty he observed as an outcome of capitalist accumulation (and the consequent creation of a relative surplus population—the unemployed) rather than as the inevitable or “natural” outcome of “overpopulation” (Harvey, 1974, p268).

2.2: Ecological Marxism after Marx

This chapter has so far given an overview of broad principles on which ecological Marxists might agree. Ecological Marxism is a historical and materialist approach that looks at how capitalist relations of exploitation and competition necessitate a particular—often damaging—relationship with the biosphere. However, beyond these points of agreement, theorists differ on some fundamental issues including how to conceptualise “society” and “nature”. According to Noel Castree, Marxian theories of nature have “see-sawed between naturalistic and social constructionist positions” (Castree, 2000, p5; Royle, forthcoming). At one extreme are those approaches that emphasise social relations to such an extent that “nature” is seen as entirely socially constructed, even as having no external existence beyond human society. Castree gives the example of the Frankfurt School theorist Alfred Schmidt, whose 1962 classic *The Concept of Nature in Marx* puts much greater emphasis on the social side of the society-nature binary and argues that nature “can only be conceived through social categories” (Castree, 2000, p15). At the other extreme are positions that stress the materiality of the non-human world, often aiming to bring nature back in. The first of these positions bears some resemblance to philosophical idealism, in other words with a set of approaches that take human culture, discourse and ideas as their starting point, whereas the second is associated with materialist philosophies which start by asserting the existence of the non-human world (Sheehan, 1993). To return to the case of the northern spotted owl with which this thesis began, the contradiction between naturalistic and social constructionist approaches has implications here as in this example some commentators emphasise the social constructedness of the owl’s habitat while others focus on the biological or “material” properties of the owls themselves.

Philosopher Kate Soper (1995) similarly makes a distinction between what she refers to as “nature-sceptical” and “nature-endorsing” positions. As she explains:
The contrast, crudely, is between discourses which direct us to the “nature” that we are destroying, wasting and polluting, and discourses that are focused on the ideological functions of the appeal to “nature” and on the ways in which relations to the non-human world are always historically mediated, and indeed “constructed”, through specific conceptions of human identity and difference (Soper, 1995, pp3-4).

Nature-endorsing approaches tend to treat nature as something that is not only real but possesses intrinsic qualities (or intrinsic worth) that is not bestowed on it by humans, whereas nature-sceptical approaches call into question an apparently self-evident nature (Demeritt, 2002). The latter stress that humans do not have direct access to “nature”; our experience of nature is always mediated by the social and cultural world in which we live. Of course, Soper is making a very broad generalisation. There are approaches that fit uncomfortably into either category. However, the distinction remains a useful starting point to unravel why different thinkers can disagree so strongly on how to approach questions of nature. Soper also usefully sets out what is at stake politically in adopting one or the other approach. Nature-endorsing views have tended to be favoured by an environmental movement concerned with protecting a threatened natural world. Nature-sceptical views, on the other hand, have been useful to, for example, feminist movements as a means to critique assumptions about the “naturalness” of existing gender relations (Soper, 1995). Nature-sceptics have refused to recognise a trans-historical “natural state of things” or to treat nature as a stable foundation on which society is built (Swyngedouw, 2015, p135). In the light of this distinction, what follows will discuss some of the contributions of ecological Marxists since Marx’s time.

In some ways epitomising the debates about ecology among eco-socialists, Ted Benton, writing in 1981, identified deep-rooted “tensions and oppositions” within Marxism itself which had led to the socialist left taking an ambiguous or even hostile stance towards environmentalism. For Benton, the historical materialism expressed by Marx and Engels in their early writings was inherently ecological, the problems were to be found in Marx’s later economic work (Benton, 1981). As Benton points out, in Marx’s discussions of the labour process in Capital he emphasises those situations where humans consciously manipulate raw materials to produce new objects, making a table from wood perhaps. But, Benton contends, not all labour processes are like this; much of agriculture involves applying labour in order to optimise the conditions for a transformation to take place, in this case providing conditions for plants to grow, rather than working on a raw material in order to transform it. In this case

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7 Benton is a founder member of the red-green study group which continues his aim of reconciling socialist and ecological thought. Founded in 1992, the group still meets regularly in London— http://redgreenstudygroup.org.uk/
human activity plays an eco-regulatory role. There are also variations in the extent to which raw materials can be freely and intentionally manipulated by humans and many also ultimately depend on appropriation from nature and will run out if not replenished. For Benton, these omissions leave Marxism inadequate in recognising limits to the development of human societies imposed by nature.

Similarly, Michael Redclift reminds us that Marx saw value as deriving from human labour power. The activity undertaken by bees in producing honey, for example, does not produce value in Marx’s terms. Redclift argues that Marx therefore failed to consider “natural limits” to “the material productive forces of society” (1984, quoted in Foster and Clark, 2016b, p112). Marxism, according to Redclift, cannot account for situations of scarcity of natural resources since it does not treat such resources as productive of value. At around the same time James O’Connor put forward the idea that capitalism is characterised by two contradictions (O’Connor, 1988). The first is between the forces and relations of production while the second contradiction occurs when capitalism undermines its own conditions of existence by damaging the natural environment. O’Connor, like Benton, proposed that Marxism ought to be combined with ideas from environmentalism; he counterposed his ecological Marxism to what he called “traditional Marxism” (O’Connor, 1988).

2.2.1: Metabolic rift theories

Moving in a somewhat different direction from these earlier perspectives, at the end of the 20th century two major contributions to ecological Marxism were published: Marx’s Ecology by John Bellamy Foster (2000) and Paul Burkett’s Marx and Nature: A Red and Green Perspective (2014 [1999]). Referring to their predecessors as “first stage” ecosocialist thinkers, Foster and Burkett see themselves as representing a second stage.8 Rather than integrating Marxism with ecology, these two thinkers have argued that there is already an ecological core to be found within Marx’s writings (Foster and Burkett, 2016).9 Foster’s work in particular has been credited with rescuing Marx’s ecological thought from obscurity so there is now greater knowledge of and interest in Marxism (and anti-capitalism) within the environmental movement (see Holleman, 2017).

Foster traces the materialist influences on Marx’s philosophy, including that of Greek philosophers Democritus and Epicurus. He has noted in particular Marx’s reference in Capital

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8 As well as Burkett, several other authors cited in this thesis have worked with Foster: Ian Angus, Brett Clark, Hannah Holleman, Kohei Saito and Richard York are all associated with the Monthly Review journal (which Foster edits) and its publishing house. All share his views on the importance of the concept of a metabolic rift.

9 Hence Foster’s choice of title: Marx’s Ecology, not Marxism and ecology.
to humans as controlling the “metabolism” between themselves and nature (Marx, 1967, p283) and sees this notion of metabolism as central to the latter’s conception of the labour process (Foster, 1999; Foster, 2000, p157). Humans, like all species, satisfy their needs by appropriating from nature and must maintain a constant relationship with the natural world in order to survive. However, Foster, in agreement with Saito’s work on alienation discussed in the previous section, argues that when humans are alienated from their own ability to labour, this leaves them no longer able to regulate their relationship with nature. This creates a “rift” in the metabolic process. Foster (1999) shows how this concept of a metabolic rift was elaborated by Marx in relation to a discussion of agriculture and soil science. Marx described how agricultural practices were removing nutrients from the soil and failing to replace them, a process inseparable from the removal of workers from the countryside as they became wage labourers in the cities (Holleman, 2017, pp168-172). Marx referred to “an irreparable rift in the interdependent process of the social metabolism” (Marx, 1981, p949; see also Foster, 1999, p379 and the discussion of metabolism in Swyngedouw, 2006, pp107-110). The metabolic rift has also been referred to as a “rift in the metabolism between man and nature” (Holleman, 2017, p169), although, as explained later in this chapter, these references to relations between humans and nature have been criticised as dualist distortions of the original formulation.

Burkett, like Foster, returns to Marx’s own writings in Capital. He argues that, far from advocating a Promethean domination of nature, Marx was fully aware of the role of natural processes in contributing towards wealth or use value (Burkett, 2014). He also took account of the constraints imposed by natural processes on production and the ways in which natural resources can be depleted. Responding to Benton’s comments about eco-regulation, Burkett shows how Marx does, in fact, distinguish between eco-regulatory and other forms of production at various points in his writings. The reason he does not start his discussion in Capital with this form of labour is because, as mentioned above, his analysis starts with a trans-historical concept of human labour, whereas eco-regulation is specific to labour in societies that practise agriculture (Burkett, 2014, pp42-45).

Perhaps more centrally, Burkett has defended the relevance of value theory to an ecological Marxism. According to Marx, commodities possess three forms of value: use value, exchange value and a third form known simply as value (Marx, 1976, chapter 1; Harvey, 1982, pp5-13). Use value can be thought of as a “social combination of labour and nature to satisfy human needs”, exchange value is effectively the price a commodity can be exchanged for on the market, whereas value is the abstract labour time embodied in commodities (Burkett, 2014, pp79-80). Bees produce a use value when they make honey (as this can satisfy a human want or need); but Marx maintained that in a capitalist society only human labour produces value. The value of this human labour power is separate from (and usually lower than) the value of
the goods or services produced, allowing the capitalist to take the difference as surplus value. Without this exploitation of labour, capitalism cannot exist (see Kallis and Swyngedouw, 2017, for a further discussion of this). Burkett points out that it is capitalism, therefore, that treats nature as a free gift. Although we might (for moral reasons) wish that capitalism would “value” nature, it is structurally unable to do so. In a capitalist system there is a tendency for use value to be subordinated to value as it drives to increase profits, although the production of a use value remains a “necessary moment of value production” (Burkett, 2014, p83).

More recently, Matt Huber has made use of Marx’s value theory to critique projects aimed at allocating monetary value to “ecosystem services”, for example where firms buy up plots of forest and market them as a profitable investment opportunity. According to Huber, these environmental valuation schemes are destined for failure when it comes to solving environmental problems. Capitalism is ill-equipped to value services such as the carbon sequestration performed by a forest as it has no way of valuing processes outside of labour and production (Huber, 2017; see also Labban, 2014).

2.2.2: The production of nature

Somewhat independently of Foster and Burkett, a group of scholars—many within geography—have sought to conceptualise what they refer to as the production of nature. In this vein, David Harvey states that “there is nothing unnatural about New York City” (1996, p186), a claim intended to challenge the assumption that nature only exists in rural or wilderness areas. It also draws attention to the active role humans play in constructing what become our own environments. Little, if any, of the world is untouched by humans; as Marx and Engels put it: “the nature that preceded human history…is nature which today no longer exists anywhere (except perhaps on a few Australian coral islands of recent origin)” (Marx and Engels, 1968). As Henderson (2009, p269) shows, Harvey’s approach is in line with Marx’s own view. For Marx, human labour (including that taking place in cities) necessarily transforms the natural world, so people in urban areas are relating to nature when they live their everyday lives (see also Loftus, 2012).

Harvey refers to William Cronon’s critique of “wilderness” environmentalism (Cronon, 1995). For Cronon, treating nature as synonymous with untouched wilderness spaces erases from history the humans who have long inhabited such places. At the same time, cities are treated as unnatural and as beyond the remit of environmental social movements (Cronon, 1995). For thinkers like Harvey much more attention should be paid to created ecosystems such as cities: Who is constructing these places? Towards what purpose? In whose interests? As explained in the following chapter, critiques of wilderness environmentalism have also been taken up by
writers in geography who are less sympathetic to Harvey’s dialectics. For example, Whatmore and Thorne have interrogated persistent assumptions around the association of “nature” with such spaces (Whatmore and Thorne, 1998; see also Lorimer, 2015).

Neil Smith makes the point even more forcefully when he proposes that humans “produce” nature (Smith, 2008; Loftus, 2017). Drawing on Henri Lefebvre’s concept of the production of space, Smith argues that we cannot understand the social production of space without also understanding nature as socially produced (Smith, 2008, p94). But, as Smith states himself, this very idea goes against all our assumptions about nature: “the epitome of that which neither is nor can be socially produced” (Smith, 2007, p22). Smith’s point is not that humans literally “produce” or build mountains. However, many aspects of nature cannot be understood as external to capitalist production: if they are not already circulating as commodities, they have the potential to be commodified and are therefore subject to capitalist logics: “in the form of a price tag, every use-value is delivered an invitation to the labour process, and capital—by its nature the quintessential socialite—is driven to make good on every invitation” (Smith, 2008, p79). In this process, produced nature assumes some of the characteristics of capital itself.10

What is more, humans are constantly producing new entities—from acidified oceans to genetically modified organisms. It is not possible to prise apart what is “natural” and what is human-produced about these “socio-natural” admixtures (Smith, 2007).

Marx never referred to nature as “produced” (Smith says that the latter’s writings on nature were incomplete and “fragmented”, 2008, p52). However, for Smith, a production of nature thesis aligns with the “direction and intent” of Marx’s thinking. Specifically, it involves a strong rejection of dualism (Castree, 2000). Rather than starting from the position that nature and society are two separate spheres that latterly come to relate to each other, Smith, drawing on Marx’s conception of a differentiated unity, says that Marx: “begins with the relation with nature as a unity and derives as a simultaneously historical and logical result whatever separation between them exists. In this way the social priority of nature is not something that must be infused from without, but something that already exists in the social relation with nature” (Smith, 2008, p48). To refer again to the sketch of Marx’s ecology at the start of this chapter, this seems to be in line with Marx’s view of human labour as the means by which humans have historically come to differentiate themselves from other species.

Smith, like Harvey, shows how the notion of nature as a realm free of human influence is an ideological commitment that developed with class society but that is maintained in today’s capitalism by various cultural practices including political, legal and literary discourse as well

10 Ecologist Ian Rappel also describes a reorganisation of nature involving the creation of a “capitalist ecology” with its own distinctive characteristics such as a tendency towards growing crops in monocultures (Rappel, 2015).
as scientific practices (Smith, 2008, pp10-30). But the ideology of external nature is also endorsed by some within the environmental movement. Environmentalists might exhort us to “save” nature, return to nature or scale back “our” impact upon it. The dominant ideology therefore assumes that humanity collectively impacts on nature rather than existing as a part of nature. Such an approach is politically problematic in that it sidesteps any discussion of the historically specific ways in which nature is produced that its critics say is needed (Loftus, 2012, p.xxii). (As will be demonstrated in chapter five, the dialectical biology of Richard Levins and Richard Lewontin has led them to a strikingly similar criticism of calls to “save the environment”).

The view that nature is external to human society goes hand in hand with the view that it is universal. It is assumed that nature is not influenced by a changing human society, and therefore does not go through changes of its own. As discussed above in relation to Marx, part of Smith’s project is, then, to historicise nature (Loftus, 2017). The dual ideology of nature as external and universal ensures that nature is treated as a static or stable ground on which society is built. These two conceptions of nature together mean that humanity can be subsumed within nature and existing societal relations can be justified by appeal to supposed “natural” laws (Braun, 2006, p196). Henderson (2009) adds that capitalism is able to treat nature as both universal and external due to processes of alienation. Humans produce nature by applying labour to the natural world but this produced nature then becomes external to them.

Smith further argues that capitalism’s production of nature has intensified in the past few decades as a new range of ecological commodities have been developed. For example, legislation in the US means that people can be given monetary compensation for preserving wetlands and there is now a market in “wetland credits”. This represents a shift from the way nature had previously been commodified, for example when wood is removed from a forest to be made into a table, to one where a wetland becomes a commodity precisely because it remains embedded in its (socially produced) natural environment (Smith, 2007). Smith draws here on Marx’s distinction between the formal and real subsumption of labour (Marx, 1976, pp429-432) to propose a distinction between the formal and real subsumption of nature. In conditions of formal subsumption, workers enter into a relationship with capital but retain some autonomy over the labour process. But the advent of real subsumption in modern industry leads to a more intensive relationship whereby the ways in which workers work are themselves transformed. With the former, absolute surplus value is being extracted, in the latter there is also an increase in relative surplus value (pp429-432). This distinction can also be made about nature’s production. As well as extracting materials and turning them into commodities, nature is now, according to Smith, being transformed in order to make it more productive by processes such as financialisation (Smith, 2007).
The production of nature approach contrasts with that of O’Connor who defines the conditions for capitalist production as external to capitalism and argues that these are not themselves “produced”. It also tends to lead Smith away from discussions of external limits to society imposed by nature (2008, p84). Alex Loftus therefore argues that the production of nature “goes against the grain of almost all Marxist conceptualisations of the environment” (2017, p2). However, Smith’s use of Marx’s value theory and his emphasis on the alienation of labour in capitalist societies are shared with the likes of Foster and Burkett although, as will be explained, Foster has been somewhat critical of the production of nature thesis (Foster, 2016b).

In Uneven Development, Smith describes his method as dialectical. Referring to accounts that simplistically treat nature and society as “interacting”, he says that, even where it is accepted that nature and society interact in complex ways, “interaction is no substitute for the dialectic” (Smith, 2008, p68). However, as Castree points out, dialectics is a complex and at times controversial topic among Marxists (Castree, 1996, p342). Therefore, the next sections of this chapter will turn to an outline of what Marxists mean by dialectics. The chapter will address Engels’ unfinished study of the dialectics of nature and show how this was taken up uncritically in the Soviet Union. However, this chapter will also attempt to recover what is useful in a dialectical methodology by showing how dialectics has been developed within geography. Rather than being “some dispensable component of classical Marxism” (Castree, 1996, p345), dialectics is one of the distinctive contributions of Marxist philosophy (Ollman, 2014)—the “algebra of revolution” (see Haug, 2005). It will be argued here that, despite some of the misuses of dialectics in the 20th century, it is nevertheless fundamental to a critical approach to ecology in the Anthropocene.

2.3: Dialectics

The methodology established and adopted by Marx and Engels is often described as both dialectical and materialist. However, dialectics and materialism are sometimes seen as incompatible (see Edgley, 1992). Materialism has mechanistic connotations whereas dialectics is more closely associated with idealist philosophies, which assert the primacy of ideas, surely the polar opposite of materialism (Bhaskar, 1992).

According to Helena Sheehan (1993), the dominant ideas in Marx and Engels’ day, among both philosophers and natural sciences, were materialist. However, while engaging with existing materialist ideas, the two thinkers rejected what they saw as the worst forms of

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11 Variations of the dialectical method are numerous, it is more accurate to refer to dialectics rather than “the dialectic” (Castree, 1996).

12 It is also referred to as “dialectical materialism” but neither Marx nor Engels used the term themselves (Graham, 1973).
materialism, specifically mechanistic and reductionist materialisms (Kircz, 1998). The mechanist approach (Engels often refers to it as “metaphysical”) separates the world out into static objects, while reductionism asserts that processes in human society are reducible to those within biology (and ultimately to physics). However, in Engels’ materialist view, human society has properties that are emergent from those of nature rather than reducible to it (Rees, 1998, p77). As will be explained in chapter five here, contemporary dialectical biologists have continued Engels’ project of criticising reductionist materialisms.

For Marx, the dialectical method is predicated on the assumption that all social systems are dynamic: “Change, development, instability…are the very conditions for which a dialectical approach is designed to account” (Rees, 1998, p6; see also Molyneux, 2012). It is opposed to those forms of thought that naturalise the existing “state of things”. In the afterword to the second German edition of Capital, one of the few accounts of his methods, Marx (1976, p103) emphasises this aspect of the dialectical method, remarking that it involves:

Recognition of the existing state of things, at the same time also, the recognition of the negation of that state, of its inevitable breaking up; because it regards every historically developed social form as in fluid movement, and therefore takes into account its transient nature not less than its momentary existence; because it lets nothing impose upon it, it is in its essence critical and revolutionary (Marx, 1887, p15).

If dialectics is “critical and revolutionary” many argue that it does not make sense to consider it as a theory separate from practice. As Loftus puts it: “Understanding the politicised environment must be a process of simultaneously intervening in and engaging with this environment” (Loftus, 2009, p162). Hannah Holleman, who refers to dialectics as one element of an ecological Marxism (Holleman, 2015) also emphasises that a Marxist method involves recognising the contingent nature of what might otherwise be seen as static processes: “Historical materialism emphasises the necessity of not taking anything about the contemporary world for granted as a given, universal, trans-historical reality” (communication by email, 3 January 2018).

Dialectical forms of thought have a long history. The word “dialectic” comes from ancient Greek philosophy. Plato established the dialectic as a formal method of argument between two people intended to lead to a consensus regarding the truth (the two initial propositions are the thesis and antithesis; the final conclusion is a synthesis of the two). Importantly, though, Marxist thinkers often use the term dialectics to refer to processes in reality rather than to the relationship between different ideas in a discussion (Haug, 2005). However, some contemporary references to dialectics retain the notion that it is about finding the resolution of
a thesis and antithesis. For example, Derek Gregory defines dialectics as “the perpetual resolution of binary opposites” (Gregory, 2009, p157).

Marx developed his own dialectical method with reference to the 18th century German idealist philosopher GWF Hegel. Hegel established many of the ideas that we now might describe as dialectical. He saw the world as an interrelated and internally contradictory totality and emphasised that this totality is in a constant process of change. Hegel also referred to a subject-object dialectic—a relation between humans and the world they encounter (Rees, 1998, pp37-45). However, for Hegel this subject-object dialectic was conceived in classical idealist terms whereby material reality was merely the reflection of an ideal “essence”. He also seems to have believed that society would progress forwards as new ideas replaced old ones. Although Marx initially rejected these views, he would later come to embrace a “critical reworking” of Hegel’s idealism, turning his dialectics into a materialist method (Castree, 1996, p344). Rather than taking ideas as their starting point, Marx and Engels, as noted previously with reference to their writings on nature, start their analysis by considering real humans and their material needs (Loftus, 2012, pp.xi-xii). This is why Marx is often referred to as taking an idealist dialectics that was standing on its head and turning it “right side up again” (Mandel, 1976, pp18-19).

Marx and Engels therefore combined two philosophical approaches: dialectics and materialism. However, as Lefebvre argued, they did this in a way that didn’t merely smash together two distinct theoretical approaches but transformed both (Lefebvre, 2009 [1940]). For Lefebvre, Marx’s dialectics transcended Hegel’s while preserving its core concepts, “what is essential in its mode of operation”. Lefebvre argues that:

> Perhaps we must accept the “rich content” of life in all its immensity: nature, spontaneity, action, widely differing cultures, fresh problems…the form to which thought raises the content must be seen as fluid and capable of improvement. Thought must accept the contradictions and conflicts in the content (p47).

Lefebvre here shows that, as well seeing the world as constantly changing, ideas must themselves also be vulnerable to being changed, negated or transcended (see also Dixon, Woodward and Jones, 2008).13

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13 In the final chapter of *Dialectical Materialism* (1940) Lefebvre turns to what he describes as “the production of man”. Here he seems to agree that “man is part of nature”. However, Lefebvre maintains that aspects of social life do become separated from the natural world (at least in human thought); the act of describing and categorising objects immobilises them, making them social objects despite their natural
As well as emphasising dynamism, dialectics also implies a particular type of change, revolutionary rather than evolutionary. Quantitative change can lead to a qualitative shift and novel forms can develop from existing systems (Edgley, 1992). Furthermore, it invokes an understanding of contradiction. Systems and structures are internally heterogeneous and the constant interaction of contradictory forces and the creation of further contradictions fuels the change and renewal of social systems (Sayers, 1980). David Harvey has paid particular attention to Marx’s use of contradiction. In *Seventeen Contradictions and the End of Capitalism*, Harvey (2014) argues that capital is inherently contradictory, indeed that it cannot exist without its internal contradictions. He says that these contradictions tend not to be resolved but to be “merely moved around”. For example, 18th century British capitalism’s use of charcoal resulted in a shortage of available land to grow food which pushed capitalists to search for other sources of fuel such as coal, but that this would eventually lead to further contradictions: urban pollution and climate change (Harvey, 2014, p4). Note here that Harvey is not using contradiction in the sense that one statement might contradict (ie cancel out) another; capital’s contradictions result from opposing tendencies present within the same process.

From a different perspective, David Barnett, in a discussion of post-Brechtian theatre, takes issue with the concern with trying to *resolve* contradictions in some interpretations of dialectics. Barnett, discussing the negative dialectics of Theodor Adorno, refers instead to an approach in which the thesis and antithesis are not resolved but held in tension: “the dialectic becomes an unwieldy beast alive with contradiction and not harmony” (Barnett, 2013). As Barnett points out, following Adorno, an emphasis on resolving contradictions is itself an artefact of bourgeois thought. To suggest that disparate elements of a system, the thesis and antithesis, could be reconciled in the same way that the capitalist commodity form makes everything commensurable is to accept some of the suppositions of the capitalist worldview. As Haug explains, Brecht developed an understanding of dialectics in sharp distinction to the Stalinist interpretation: “which stirs everything up in order to calm it down, which transforms the things in flux into something fixed, ‘elevates’ matter into an idea, is just the bag of magic tricks for such shit-awful times” (quoted in Haug, 2015, p257). Brecht’s approach, emphasising unresolved contradictions, was an outlook that, far from implying the inevitable resolution of society’s contradictions with the emergence of socialism, offered no such guarantees. Interestingly for the discussion of scientific knowledge in this thesis, Brecht...
argued that dialectics “is necessary because of the unbridgeable difference between thought and reality”. Whereas most ways of trying to observe or represent reality are founded on resolution and conclusion, in reality, Brecht says, processes are not resolved so a more agile method is needed to try to at least account for this (Haug, 2005, pp256-257).

Dialectics is, in summary, a relational form of thought that emphasises dynamism, totality and irresolvable contradiction (see Harvey, 1996, chapter 2; Holleman, 2015). As Castree (1996) points out, this way of thinking has been particularly interesting to geographers. In what follows, this chapter addresses this specifically geographic dialectics before going on to address debates over the dialectics of nature.

2.3.1: Ollman and Harvey’s approach

In 2008 a special issue on dialectics of Environment and Planning: A featured various contributions from geographers. As its editors noted, even sceptical authors have admitted that a method that “tracks change not in circles but in spirals” has an enduring appeal within the discipline (Dixon, Woodward and Jones, 2008, p2549). David Harvey, Erik Swyngedouw and Andy Merrifield have all developed dialectical approaches to questions of space, place, nature and society with Harvey’s work on this subject becoming particularly influential in geography. Therefore, Sheppard (2008) is able to discern a distinctive “geographic dialectics”. Harvey, Swyngedouw and Merrifield are influenced by Lefebvre and by political theorist Bertell Ollman, for whom dialectics “explains nothing, proves nothing, predicts nothing and causes nothing to happen” (Ollman, 2003, p12; Castree, 1996, p344). Dialectics, for Ollman, is “a way of thinking about the relations and processes in the world, and a method for studying them” (2014, p573); it is an attempt to grasp the constantly changing nature of the world, to understand reality as it is—in a constant state of flux—as well as a critique of attempts to separate the world into static and independent bodies.

Ollman views reality as consisting of multiple processes that undergo continual change and are constantly relating to each other. His interpretation of dialectics therefore defies the common sense view that the world consists of separate things that are more or less discrete.15 This is described as a philosophy of internal relations. While philosophies of external relations rest on the assumption “that reality consists of things…with boundaries that are distinct and relatively stable, which can undergo changes and get into relations” (Ollman, 2014, p574), for Ollman reality is instead seen as fundamentally constituted by relations; a thing would not be what it is

15 Although dialectics originated with Plato, this version is perhaps more reminiscent of the philosopher Heraclitus, who emphasised the constantly changing nature of the observed world, rather than the back and forth exchange of arguments associated with Plato (Haug, 2005).
without the relations in which it exists (see also, Castree 2005, pp232-233). Importantly, this approach is simultaneously an ontology and an epistemology, a statement about the nature of reality as well as a method for understanding and representing that reality. For Ollman, ontology and epistemology are themselves internally related; ways of understanding the world must also relate to the way the world is (Ollman, 2014, p574).

Ollman’s dialectics allows the thinker to grasp something about a world that is constantly in motion (Ollman, 2003), it places the emphasis on processes and flows rather than form and fixity, allowing for an understanding of the processes driving change, how those processes sometimes crystallise into things that might appear solid and fixed, as well as what forces pull them apart (Harvey, 1996, p81; Braun, 2006, p209). This is not incompatible with the emphasis on contradiction discussed above with reference to Harvey’s work. If what appears to be a thing is constituted out of diverse processes it is possible that some of those processes will act in opposition to each other producing internal tensions (Harvey, 1996, p54). Such an approach inevitably sees dynamism as an inherent property of things rather than seeing things as becoming endowed with dynamism as a result of the influence of outside forces: “space and time are neither absolute nor external to processes but are contingent and contained within them” (Harvey, 1996, p53). As a methodology, dialectics therefore treats dynamism as central to analysis rather than peripheral to it.

Critics might argue here that it is impossible for a thinker to grasp the whole of reality at once; that it is therefore necessary to understand the world as composed of bounded entities to prevent “the study of anything spilling over into everything” (Ollman, 2014, p574). In answer to this, Ollman shows how Marx employed a process of abstraction, bringing one aspect of a complex system into view momentarily in order to focus on it from a particular vantage point. But this does not imply treating that particular aspect as operating distinctly from other elements of a totality (Ollman, 2003, 2014).

One of the best-known endorsements for such an approach within geography comes from David Harvey in a chapter of Justice, Nature, and the Geography of Difference (1996, chapter 2) where he lists eleven attributes of dialectical thought. Harvey first elaborates this way of thinking in a critique of Peter Haggett’s attempt to incorporate elements of a systems theory approach from the natural sciences into human and physical geography (Harvey, 1995). Systems theory is more concerned with wider processes and relationships between things than explicitly reductionist programmes. But it is nevertheless still preoccupied with concrete things that exist prior to the processes that constitute them, “we get to understand processes by looking either at the attributes of what appear to us in the first instance to be self-evident things or at the relations between them” (Harvey, 1996, p49). Dialectics, by contrast, is a relational ontology that inverts the systems theory approach by prioritising the flows or processes in
which things exist. Harvey also usefully counterposes dialectics to Cartesian thought (here he actually draws on the work of Levins and Lewontin and their 1985 book *The Dialectical Biologist*). Whereas a Cartesian thinker might assume that reality can be understood by breaking it down into its constituent elements and studying each in isolation, Harvey rejects the distinction between parts and wholes on which Cartesianism relies, stating that parts and wholes are “mutually constitutive of each other” (Harvey, 1996, p53).

Elsewhere Harvey demonstrates how Marx builds an understanding of the workings of capitalism by examining value, use value and exchange value but by treating each as related to the others rather than assuming that each of these elements of the commodity form can be understood in isolation. As he argues, this dialectical procedure allows Marx to analyse a system that is both complex and inherently contradictory (Harvey, 1982, p2; see also Castree, 1996). Using Ollman’s terminology, Harvey compares the method of considering each relation in turn as being like looking at the system under observation through a series of separate “windows”. Through one window we might see part of the thing we want to understand, looking at it through a second window will reveal further aspects of it that were formerly hidden from view. This gives more of an insight when we return to the first window. This method allows Marx to proceed from abstract concepts such as the three forms of value to build up a progressively more concrete picture of what he wants to understand (Harvey, 1982, p2). As Harvey explains, this is why Marx takes the reader through a lengthy explanation of the exchange of commodities before the answer to the questions of what value is or where profits come from can come into view. Harvey has also sometimes employed the concept of “moments” to refer to the physical things that express general processes (Castree, 2005, p233). In this way individual aspects of a social structure can be analysed while still seeing them as embedded within that structure (see also Hartsock, 2006).

In geography, extending the dialectical method has led to a rethinking of issues of spatiality. Merrifield (1993) points out that the relationship between “space” and “place” is often left unexplained leading geographers unintentionally to make the Cartesian assumption that space can be divided up and treated as the sum of a number of places. Drawing on Lefebvre’s work on the production of space, Merrifield suggests that a place can itself be seen as constituted—produced—out of various broader political and economic practices (Merrifield, 2002). As these processes “stretch beyond specific localities” (Braun, 1998) this way of thinking sees place as important but avoids drawing a binary distinction between the global and local. Furthermore, as places are made up of social forces they don’t merely act as passive backgrounds against which social processes play out but themselves reflect those social forces. Soja (1980) similarly refers to a socio-spatial dialectic in which societies and spaces are seen as mutually constitutive. Swyndedouw brings Harvey’s work into conversation with
Haraway’s notion of the cyborg as well as Smith’s production of nature to demonstrate how the things that make up cities are produced in historical and geographically specific ways. Using the example of water provision, he also insists that cities are socio-natural hybrids, irreducible to either the social or the natural (Swyngedouw, 1996).

Likewise, Harvey’s dialectical thinking can apply equally to “society” and “nature”. He states that: “there is as much evidence for the argument in the natural and social world as there is evidence for any alternative proposition” (Harvey, 1996, p58; see also Braun, 2006) and uses examples from biology and physics to illustrate his points. Likewise, for Ollman, if things are seen as constituted by processes, it makes little sense to attempt to separate those things that are “social” from those that are “natural”. However, as the following section will show, attempts to develop a materialist dialectics of nature, which have their origins in Engels’ writings, have been met with controversy and even been rejected entirely by some Marxists.

2.4: Engels and the natural sciences

In a letter to Marx in 1873, Engels described the natural sciences as the study of “matter in motion” (quoted in Sheehan, 1993, p24). Over the next ten years he embarked on a study into how the method used by Marx to analyse the circulation of value in *Capital* might also be applied to nature. For Engels it was entirely possible for scientists to adopt a particular philosophical worldview such as a dialectical outlook in order to make sense of their observations. Using arguments that would be familiar to the radical scientists of the 20th century (see chapter five), he pointed out that scientists who claimed to be carrying out purely empirical work without explicit philosophical influence were misled. These scientists would still have an implicit philosophical basis for their ideas whether or not they admit it—and often “the most mediocre vulgar philosophy” (Engels, 1939 [1883], p105). Engels never completed his *Dialectics of Nature*, putting it aside after Marx’s death to prepare volumes two and three of *Capital* for publication. However, the collection of manuscript pages was translated and published in the Soviet Union in 1927 (in Russian and German) and in English in 1939 (Engels, 1939; see also Sheehan, 1993).

The biologist JBS Haldane, in a preface to the English edition of *Dialectics of Nature*, described Engels as “probably the most widely educated man of his day” (foreword to Engels, 1939 [1883]). Both Marx and Engels read the work of, and communicated regularly with, natural scientists such as the chemist Carl Schorlemmer (Angus, 2017) and the zoologist and evolutionary biologist E Ray Lankester (Gould, 2006). Marx also had some knowledge of anatomy, mathematics and geology as well as the soil science that was influential to his understanding of metabolism (Foster, 2000, p17; Saito, 2017). Marx at times referred to his
Engels’ insight that the natural sciences are about matter in motion must therefore be understood in the context of real developments in the sciences when he was writing and of which he would have been aware. Science had previously been based on models—such as Isaac Newton’s laws of mechanics—of processes that can be explained using reversible equations. However, when Engels was writing, science had started to emphasise irreversible processes where systems do not just change in a reversible way but develop through time, undergoing historical transformation. Time and matter are no longer seen as distinct as in Cartesian thought; rather, change is seen as intrinsic to processes in nature (Callinicos, 2006, pp210-211). In particular, when Engels was writing, Charles Darwin was demonstrating how species undergo irreversible qualitative change over time.

This thesis will return to the relationship between Marxism and Darwinism later; but it is important to note that historical change was emphasised in other scientific disciplines in the 19th century, not just biology. In physics, Joule had demonstrated that heat can be transferred into mechanical energy and vice versa. In geology, Lyell had discovered the continual creation and destruction of strata within Earth’s crust (Engels, 1939 [1883]). For Engels:

Modern materialism embraces the more recent discoveries of natural science, according to which nature also has its history in time, the celestial bodies, like the organic species that…people them, being born and perishing. And even if nature, as a whole, must still be said to move in recurrent cycles, these cycles assume infinitely larger dimensions. In both aspects, modern materialism is essentially dialectic (Engels, 1970 [1880]).

Sheehan (1993) argues that Engels used evidence from the natural sciences to develop his theory of dialectics and shows how he was able to engage in some debates among scientists by considering questions in the light of a dialectical worldview. Although many of his assumptions have been disproved, some of Engels’ contributions to contemporaneous debates in science have since been proved correct (Graham, 1973). Notably, in his unfinished work “The Part Played by Labour in the Transition from Ape to Man” (often published as part of Dialectics of Nature), Engels supposed that early humans’ erect posture freed up their hands and allowed them to develop tool use and that the use of tools in turn allowed for the development of larger brains. So, for Engels, humans’ ability to carry out labour, in other words to manipulate the environment, played a role in the evolution of humans as a species. Engels’ suppositions contrasted with the views of most evolutionists, including Darwin, who
thought that large brain size evolved first and that the ability to use tools followed this (see Blackledge, 2002, pp11-12). But these ideas are similar to modern theories of gene-culture coevolution (Foster, 2000, p203) and to the understandings of human evolution rooted in niche construction discussed in chapter six of this thesis.

2.4.1: The three laws of dialectics

However, despite some of Engels’ informative insights, the section of *Dialectics of Nature* that is perhaps the best remembered concerns his proposal that three “laws” of dialectics can be deduced by studying society or nature. The laws, developed from a study of Hegel’s philosophy, are:

1. The law of the interpenetration of opposites.
2. The law of the transformation of quantity into quality and *vice versa*.
3. The law of the negation of the negation.

The first of these supposes that objects and systems have internal opposing qualities. This is analogous to the way in which a magnet has a north and south pole. Opposites conflict with each other but are also mutually constitutive—there can be no south pole on a magnet without a north pole (Gollobin, 1986). In a common example of the second law, heating a pan of water will result in quantitative change as the temperature of the water increases; however, at a certain point this will tip over into qualitative change as the water turns to steam, which displays entirely different properties (Engels, 1939). The second and third laws are themselves supposed to develop from an acceptance of the first; quantity and quality are two opposing attributes of things that interpenetrate and interchange with each other.

These laws are, for many, obscure and antiquated. The very idea that processes in the natural world, which seems to follow its own rules or none at all, can be usefully abstracted to just three laws is difficult to countenance. And there have been some awkward attempts to graft the laws onto observations about the natural world. For example, it has sometimes been proposed that an oak tree “contradicts” the acorn from which it grows, and that this “contradiction” is resolved by the production of a further acorn (see Callinicos, 2006 for a critique). Therefore, *Dialectics of Nature* is often criticised as an attempt to find convenient evidence in the natural world for such laws. Sartre dismissively argued that: “the only dialectic one will find in nature is a dialectic that one has put there oneself” (Sartre, 2004 [1960], p31).

Even more problematically, contradiction between two opposite forces where one “negates” the other has been proposed as a driving force of change in society. The law of the negation of the negation is sometimes taken as an example of how the establishment of capitalism
“negated” earlier forms of society but in this process produced a class capable of negating capitalism in its turn—the proletariat. Perhaps unsurprisingly given the implication that capitalism will “necessarily give rise to socialism” this use of dialectics has been criticised as deterministic (see Rees, 1998, p81). Contrast this with Ollman’s more open-ended approach described in the previous section.

The controversy surrounding the dialectics of nature isn’t helped by the fact that Engels didn’t live to complete or defend his study of nature. Marxists have therefore tended either to accept its assertions uncritically or to dismiss them entirely as an ill-informed diversion from Marxist thought. As will be discussed in the following section, the idea of a dialectics of nature is now associated for many with the crude attempts to develop a “proletarian science” in the Soviet Union and with apologetics for this on the part of some Communist intellectuals in the West. Chapter five will contrast the approach put forward by Marxist scientists of the 1970s and 1980s, one that actively embraces the contradictions inherent in scientific activity and therefore avoids some of the problems of proletarian science. However, the Soviet approach is discussed here as a negative example of one of the pitfalls that Marxist science might fall into.

2.5: A Proletarian science?

After Marx and Engels, the next major attempt to combine Marxism and the natural sciences came about with the Russian Revolution of 1917, which provoked a flowering of scientific ideas, as well as the better-known experiments in avant-garde art, film and literature (Parrington, 2017). Prominent scientists at the time included Vladimir Vernadsky, who popularised the term biosphere, Alexander Oparin, whose ideas on the origins of life were ground-breaking, and Nikolai Vavilov, who greatly expanded knowledge of global plant biodiversity (Graham, 1973). John Bellamy Foster argues that there is still much of use in the insights of scientists from this period and in particular that Vernadsky’s ideas should be revisited by environmental theorists. Vernadsky understood the biosphere as encompassing complex interconnections operating on a global scale where there is no sharp distinction drawn between the organic and inorganic elements of the system. He referred to humanity as a

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16 Another potential criticism of Engels is that the ideas of the 19th century may have been surpassed by developments within the natural sciences themselves. If science in the 19th century was dominated by materialist ideas, a paradigm shift in physics in the 20th century seemed to erode the foundations of materialism. Quantum physics suggested that the world could no longer be divided into discrete atoms that behave in a predictable way. Sheehan (1993) argues that new discoveries in physics around the turn of the century led the way to a return to idealist views. For thinkers such as Ernst Mach, a physicist whose ideas were influential among some Russian Marxists, science could no longer make ontological claims about an actually existing world. Instead, ideas about the world were reduced to a series of sensations and the role of science was merely to order and categorise the experience of the senses (Sheehan, 1993).
“global force” long before contemporary discussions of the Anthropocene (Foster, 2016a). Oparin similarly emphasised the active role of organisms in transforming their surroundings. He supposed that organic life emerged from inorganic matter under particular conditions in the early Earth (these ideas, the “primordial soup” hypothesis, are now widely accepted). When life did arise, living things substantially altered the planet’s atmosphere by adding oxygen which then obliterated the oxygen-free conditions that had enabled life to evolve in the first place (Foster, 2016a). According to historian Loren Graham, Oparin’s insights were related to his developing interest in Marxism. He understood the origin of life in materialist terms and as arising from the “movement” of matter (Graham, 1973, chapter 7).

2.5.1: The scientific left in Britain

At around the same time a scientific left, many of them sympathetic to Marxist ideas, developed in Britain, with many making major contributions to scientific knowledge. Prominent left-wing scientists of the time included Haldane, pioneering X-ray crystallographer JD Bernal, developmental biologist and early advocate of epigenetics Conrad Waddington and physicist PMS Blackett (Sheehan, 1993, p303). Haldane, along with Ronald Fisher and Sewall Wright, was instrumental in establishing the modern synthesis of Darwinian natural selection and genetics on which the foundations of biological theory are built. The synthesis combined evolutionary biology after Darwin with the mathematical rules for how characteristics are passed down from parent to offspring initially investigated by Gregor Mendel, thereby integrating and building on two previously separate strands of biological theory (Dronamraju, 2017).

Haldane contributed a science column to the Communist Party’s Daily Worker and joined the party officially in 1942. It was Haldane who suggested that Lawrence and Wishart (the CP publishing house) publish Engels’ Dialectics of Nature in English. In the introduction to the text he described how useful he found Engels’ work; had it been published earlier it would have saved him a lot of “muddled thinking” (Haldane, introduction to Engels, 1939). However, as Gary Werskey (1988) argues, Haldane never shook off his commitment to the Communist Party’s interpretation of Marxist politics; a vision of socialism brought about by

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17 As Sheehan explains, in the 1930s a Labour government fell, former Labour members turned to Communism and fascism was on the rise across Europe: “The middle ground was slipping away by the hour” (Sheehan, 1993, p306). The threat from the right, the economic crisis and the looming world war all played a role in radicalising British intellectuals of the time.

18 John Bellamy Foster has also borrowed the term “modern synthesis” to represent the synthesis of classical Marxism and ecological science represented by second stage ecosocialism—Foster, 2016b, p5.

19 Haldane also independently developed a very similar theory of the origin of life to Oparin (Sheehan, 1993, p318).
great leaders rather than workers’ self-activity. For Werskey, this treats scientists as separate from and sitting above the rest of society. It suggests that a more just world can be brought about by increasing investment in science and implementing socialist planning to make better use of scientific findings. Hilary and Steven Rose, commenting on the differences between the 1930s radical scientists and the later generation (of which they were a part), point out, therefore, that many of the 1930s generation assumed that science could be harnessed “to the service of society” with the Soviet Union providing the model, while the content of science itself went relatively unquestioned (Rose and Rose, 1972).

However, not all of the 1930s radical scientists neglected to address the content of science. As evolutionary biologist Rob Wallace (2016a) explains, the ideas of Christopher Caudwell, also a member of the Communist Party, prefigured many of those of the dialectical biologists of the 1970s. Notably, he criticised what he referred to as “the bourgeois separation of organism and environment” long before Levins and Lewontin would publish their own strikingly similar thoughts on the relationship between organism and environment which will be further discussed in chapter six here (Sheehan, 1993, pp350-383).

In 1931 a delegation of Soviet scientists, led by Nikolai Bukharin, visited Britain to take part in a session of the International Congress of the History of Science and Technology. The Soviet papers highlighted the ideological assumptions of science, drawing a sharp distinction between science in the Soviet Union and the “bourgeois science” of the West. In one of the presentations, Russian physicist Boris Hessen explained Newton’s achievements with reference to the social and political context in which they arose: the early capitalism of 17th century Britain (Rose and Rose, 1972, p108). Loren Graham therefore credits Hessen as one of the founders of this approach to the history of science (Graham, 1985). While it is widely accepted today that scientific knowledge must be understood in context, in 1931, the Soviet speeches had a profound effect on those who heard them. Sheehan describes how it shocked many in the audience into silence, referring to the dismissive statement of a reviewer in the leading journal Nature: the “laws of nature are the same for all of us” (Sheehan, 1993, p307). The Soviet Embassy in London was rapidly transformed into a publishing house, publishing the Soviet papers under the title Science at the Crossroads.

2.5.2: Lysenko

But science in the Soviet Union was, by this time, already taking a tragic turn. Scientists who had found some support for their work in the early years of the revolution were increasingly

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20 Caudwell, a polymath who wrote fiction and poetry as well as commenting on physics, maths, biology and psychology died in the Spanish Civil War aged just 29 (Wallace, 2016).
threatened by Stalin’s counter-revolution. At around the time of *Science at the Crossroads*, the Ukrainian agronomist Trofim Denisovich Lysenko was beginning his experiments into the treatment of crop seeds. Lysenko proposed that vernalisation (pre-treating seeds at low temperatures before sowing) would increase their yield; carrying out experiments that were certainly interesting to a society desperately looking for practical ways to feed the population (Levins and Lewontin, 1985, p174). Lysenko went on to argue that, when different crops were manipulated by being planted in different conditions, they acquired characteristics that could be passed on to the next generation (Rose and Rose, 1972, p113). Part of the theoretical basis for Lysenkoism was the rejection of a separation between organism and environment; in contrast to Darwinian evolution, Lysenko did not see the inheritance of genes as a distinct process from the influence of an external environment. This led to the belief that organisms could freely assimilate certain aspects of their environment and reject others. New species were also thought, by Lysenko and his followers, to evolve when an *individual* organism encounters a particular environment. This removed the (Malthusian influenced) emphasis on competition between individuals in a population in Darwin’s conception of natural selection (Levins and Lewontin, 1985, p167).

Lysenko would later reject the existence of genes entirely. The idea that information is passed from parent to offspring was seen as a metaphysical deviation and incompatible with the emphasis on materiality that Lysenko’s supporters saw as key to their Marxism. The notion of an unchanging genetic particle was particularly problematic as it went against the Lysenkoists’ stress on the mutability of living things and was seen as denying the reality of a dynamic natural world (Levins and Lewontin, 1985, p169). Sheehan shows how genetics was classed as “idealist”, a “bourgeois” mystical science that contrasted strongly with the “dialectical materialist” worldview, and places this in the context of a long debate between idealist and materialist Marxist philosophers of science (Sheehan, 1993, chapter 3 and pp200-201).

Lysenko’s ideas were quickly seized upon by the Soviet leadership (Sheehan, 1993, pp202-203; Lecourt, 1977, pp18-19). By 1940, Lysenko, with the personal support of Stalin, was made director of the Institute of Genetics. But the teaching and practice of genetics was banned. The regime destroyed textbooks and many leading geneticists including Vavilov and Hessen found themselves replaced by more compliant scientists and imprisoned (Soyfer, 2011). The approach developed by Lysenko and his supporters clearly contrasts with that of Marx and Engels, who drew on the ideas of mainstream thinkers in the sciences even where they differed politically (Gould, 2006). However, Engels’ unfinished manuscript on the dialectics of nature undoubtedly influenced Soviet policy on biology and agriculture. In

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21 The double helix structure of DNA had yet to be discovered at this point but many biologists accepted that there was some kind of molecular mechanism by which characteristics could be inherited.
particular, the three “laws” of dialectics seem to prefigure the dogmatic approach of attempting to develop a proletarian science. But was Engels himself at fault? Barot (2010) reminds readers that *Dialectics of Nature* was an unfinished work. He cautions against either following its principles uncritically or dismissing it entirely. Sheehan (1993) similarly argues that critics need to be more discerning about what Engels’ contribution to scientific debates is, viewing his work more as a pointer towards areas of further study than a sacred text. However, Barot also adds that the proposed series of laws in *Dialectics of Nature* represents “a dangerous turn that paves the way for its later dogmatic transformation” (Barot, 2010, p144).

Furthermore, some commentators have argued that Engels’ views on nature represent a fundamental departure from Marx’s own perspective and justify his dismissal from the Marxist tradition entirely (see Rees, 1994). For example, George Lichtheim (1964) proposed that Marx and Engels had completely different viewpoints and that Engels contaminated Marx’s philosophy with positivist ideology, calling this “a travesty”. As discussed above, Marxism is often seen as a *critical* science, concerned with changing the world, rather than the type of science that merely observes and interprets the world as it exists (Edgley, 1983, p291).

Some suggest that Marx either disagreed with Engels but didn’t have time to provide a proper critique of his friend’s work or was unaware of the details of what Engels was writing. However, this seems unlikely as the two regularly visited and wrote to each other to discuss their respective work—Engels first proposed writing a dialectics of nature in a letter to Marx. It is more probable that Marx and Engels established a division of labour between them whereby Engels would deal with questions of nature, leaving Marx to focus on economics, although the latter also read and commented on drafts of Engels’ works on science (Angus, 2017, p24; for a systematic critique of the various proposals that Marx and Engels disagreed see Sheehan, 1993). As Weston (2012) explains, Marx also sometimes chose to illustrate aspects of his method using examples from the natural sciences. In *Capital* he uses the example of elliptical motion of bodies in space to explain how a single thing can have two properties that contradict each other and that these contradictions are not resolved: “it is a contradiction to depict one body as constantly falling towards another, and as, at the same time, constantly flying away from it. The ellipse is a form of motion which, while allowing this contradiction to go on, at the same time reconciles it” (Marx, 1976, p70). For Weston, this further supports the argument that Marx essentially agreed with Engels.

However, Hungarian philosopher Georg Lukács, provided what, for some, is a devastating argument against applications of dialectics to anything other than social relations (Vogel, 1996, chapter 1). Lukács’ thought was influential to what became known as Western Marxism (as opposed to the Soviet or Eastern tradition) and to recovering the Hegelian influence on
Marxism and its emphasis on praxis (Loftus, 2012, p50). Nevertheless, his ideas raise problems for the idea of a dialectics of nature.

2.5.3: Lukács and the dialectics of nature

Lukács rarely referred to questions of nature or the environment, showing an “almost exclusive concern with the dialectic in society” (Rees, 1998, p252). Furthermore, in an infamous footnote to the 1923 book *History and Class Consciousness* he argued that Engels was mistaken to propose a dialectics of nature:

> The misunderstandings that arise from Engels’ account of dialectics can in the main be put down to the fact that Engels—following Hegel’s mistaken lead—extended the method to apply also to nature. However, the crucial determinants of dialectics—the interaction of subject and object, the unity of theory and practice, the historical changes in the reality underlying the categories...are absent from our knowledge of nature (Lukács, 1971, p24).

For Lukács, there is a dialectical relationship between reality and ideas; dialectics describes only a subject-object relation (Smith, 2009, p358). Dialectics is therefore intended as an epistemology—referring to the way people interpret the world around them—rather than a method derived from a study of the workings of nature (Vogel, 1996, p16). Furthermore, in Lukács’ work there is a clear relationship between commodification and agency. For Marx, capitalism tends to turn objects into commodities by treating them as having value only in that they can be exchanged. As discussed in relation to value theory and ecology, the relevant property of a commodity from the point of view of the capitalist is its exchange value rather than its use value. For Lukács, human labour power is also given a price when humans are compelled to work for a wage—the working class effectively become commodities themselves (Lukács, 1971 [1923]). But, as human labour power is the ultimate source of the exchange value inherent to all commodities, labour power is the “absolute” or apical commodity (see Callinicos, 2006, p248). Labouring humans are jointly the subject and object of history—objectified and turned into commodities but at the same time also able to act in the world as subjects. This role within the system also provides the working class with the means to understand the capitalist system:

> The worker can only become conscious of his existence in society when he becomes aware of himself as a commodity...his consciousness is the self-consciousness of the commodity; or in other words it is the self-knowledge,

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22 The resulting fetishisation of commodities is referred to as reification.
the self-revelation of the capitalist society founded upon the production and exchange of commodities (Lukács, 1971, p168).

The working class, therefore, uniquely have the potential to comprehend the system they find themselves implicated in, to understand it from the standpoint of the proletariat (although of course this potential for class consciousness is not always realised). But furthermore, for Lukács the key to understanding a system is to play an active role within it. Workers will only understand the capitalist world by acting and trying to change it. If we accept Marx’s view that non-humans do not contribute to exchange value by their activities as do humans—as discussed earlier with the example of bees producing honey—it follows that non-humans don’t take on the same role within the system as subject and object of history. So, Marxism as a way of understanding the world is inseparable from it as a way of intervening. Lukács refers to this method as dialectics: “materialist dialectic is a revolutionary dialectic” (Lukács, 1971, p2) echoing Marx’s own point (previously quoted) about dialectics being inherently critical.

In some ways Lukács’ work also addresses the status of Marxism as a science itself. While he maintains that Marxism aims to get at the “essence of things”, he differentiates Marxism from the type of science carried out by a neutral, distanced observer analysing a phenomenon which they do not attempt to influence. Social scientists often face problems of subjectivity—how can we come to valid conclusions about a human society of which we are part while avoiding bias? However, in Lukács’ work the problem is turned on its head. It is precisely because humans are part of society that they can attempt to understand it. As Slavoj Žižek puts it, Lukács articulated the notion of “partiality as not only not an obstacle to but a positive condition of Truth” (quoted in Callinicos, 2006, p248).23

By contrast, in a later passage of History and Class Consciousness the dialectics of nature is referred to as something that “can never become anything more exalted than a dialectics of movement witnessed by the detached observer” (Lukács, 1971, p207). Such movements cannot be truly dialectical for Lukács as, for him, dialectics is about “transforming, rather than merely observing, reality” (Loftus, 2012, p61; see also Loftus, 2013) and nature is assumed to merely be observed. Kircz (1998) makes a similar point, arguing that there is something undialectical in Engels’ formulation—or at least something that could, in the wrong hands, be interpreted in an un- dialectical way. Engels seems to have attempted to distil the experience of the natural world into a set of laws which can then be applied back to the material world. This in itself creates a dualism between the observed world and the observing scientist, creating an

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23 Lukács was intensely critical of positivist interpretations of Marxism. At the time when he wrote History and Class Consciousness such versions of Marxism were primarily associated with the policies of the Second International and particularly with Bernstein and the German SPD (Lukács, 1971, p5).
external relationship between observer and observed as it suggests that one can influence the other in a deterministic way. Neil Smith also criticises the dialectics of nature briefly in *Uneven Development*. Smith argues that Engels treated nature as external and therefore removed the necessary element of a subject-object dialectic (Smith, 2008, pp34-35).

However, other have been critical of Lukács’ treatment of dialectics as (exclusively) a social theory. Antonio Gramsci questioned whether it is itself dualist to propose that there are methods proper to accounting for human history that are not also relevant to nature:

> It would appear that Lukács maintains that one can speak of the dialectic only for the history of men and not for nature… If his assertion presupposes a dualism between nature and man he is wrong because he is falling into a conception of nature proper to...idealism which does not in reality succeed in unifying and relating man and nature to each other except verbally. But if human history should be conceived also as the history of nature (also by means of the history of science) how can the dialectic be separated from nature? (Gramsci, 1971, p448).

Gramsci cautioned against seeing dialectics *in* nature, ie nature as witnessed by a detached observer, although he seems to have been broadly sympathetic to a dialectical understanding *of* nature. For Gramsci it is possible to understand nature dialectically as long as it is possible to understand human history in such a way; natural history is inseparable from human history (Wainwright, 2013). It is possible to adopt a dialectical approach to nature that avoids the trap of seeing nature as external while also avoiding the idealism of seeing dialectical relations only in relations between humans. Strangely, if Gramsci is right, Smith falls into the same trap of seeing nature as external and universal that he himself criticises. What is needed, rather than accepting that nature is external and therefore non-dialectical, is to develop an approach to the dialectics of nature that also recognises the ways in which natures are produced.

Some theorists have attempted to avoid dualism by arguing that human action has some unique qualities not found in the rest of nature while also maintaining that society and nature are inseparable, a position that stands to reason as, of course humans are part of nature and evolved from non-human ancestors. John Rees argues that nature can be understood as following dialectical laws if it is also accepted that nature and society, though interpenetrating, are ultimately qualitatively different (Rees, 1998, p75; see also Smith, 2009) echoing Lefebvre’s statement that “the sciences of nature and the social sciences are specifically creative” (Lefebvre, 2009 [1940], p107). For others the dialectical approach is notable for its emphasis on emergence; reality is stratified with different processes or laws that operate at different levels. This allows for some continuity between processes in nature and in society but
also some novel phenomena—consciousness, perhaps—that are specific to human society (see Callinicos, 2006 for a Marxist account influenced by critical realism).

Lukács himself adopted something like this approach in later works. In Lukács’ *Defence of History and Class Consciousness* (published in English in 2000), he does accept the existence of a dialectic of nature, remarking that “self-evidently society arose from nature” and that the dialectic must therefore be “already effective as a principal of development of nature before society” (Lukács, 2000 [1925-6], p102). Lukács also refers at times to nature as socially mediated, although elsewhere and in contradiction to this he continues to deny that dialectical methods can be applied to the study of the natural world and reasserts nature’s “ontological objectivity”. Alex Loftus, drawing on Steven Vogel’s reading of Lukács (Vogel, 1996, chapter 1), therefore argues that Lukács’ whole approach is limited by its idealist conception of human labour and his lack of attention to the role of practical activity in producing natures (Loftus, 2012, p66).

Providing a route out of the impasse represented by Lukács’ intervention that is particularly relevant to this thesis, Paul Burkett, in a paper originally written following the publication of *Tailism and the Dialectic*, has taken issue with some of Lukács’ assumptions about the natural sciences (Burkett, 2013 [2001]). When Lukács asserts that: “the dialectics of nature can never become anything more exalted than a dialectics of movement witnessed by the detached observer” (Lukács, 1971, p207) he shows a lack of understanding of the actual practice of science. Lukács implies that natural scientists remain “detached” from their object of study, something Burkett describes as an idealistic conception of the scientific method. Instead Burkett argues that Lukács should have developed an “immanent critique of natural science” (Burkett, 2013, p6) and adopted a goal of creating a more historical materialist approach to the natural sciences, a baton he argues was taken up by Levins and Lewontin. These biologists have denied that natural sciences are disinterested and that social sciences are uniquely subjective, pointing out some of the similarities between the two (Levins and Lewontin, 1998).

Burkett’s second contention to Lukács’ approach is that the role of subject as well as object may not be exclusively human. Lukács did not address the question of subjectivity among non-humans and seems to assume “that extra-human nature has no subjectivity”. Burkett hints that this is “a highly problematic claim given recent research on animals” (Burkett, 2013, p7). However, what this research on animals might consist of is left unexplored. This is an area where the notions of non-human agency being discussed within the social sciences with the emergence of new/vital materialisms (see chapter three) but also a renewed engagement with the ideas on non-human agency of the dialectical biologists should prove fruitful.
2.6: The return of the dialectics of nature debate

Attempts to apply dialectics to issues of science and nature had disastrous consequences in the Soviet Union that anyone discussing dialectical biology today ought to acknowledge. According to Hilary Rose, the whole Lysenko episode shut the door on Marxist discussions of science for decades, leading to the idea that there is only one science—bourgeois science (Rose, 2004 [1983]). So, with the dialectics of nature so tarnished by its application in the Soviet Union, is there any reason to resurrect it? It is the contention of this thesis that dialectics remains central to the Marxist critique of capitalism and that, as Gramsci suggested, it makes little sense to separate human history from natural history. Therefore, dialectics still has something to say about socio-natural processes, but not as a set of rules to be applied to nature from the outside. Fortunately, there are interpretations of dialectics that treat it neither as a motor force of history nor as a dogmatic list of laws. In particular, it is argued here, the dialectics of Ollman, Harvey and their associates, that has become influential in geography, offers such a flexible methodology.

Interestingly, Harvey’s approach accords with some of Engels’ statements about dialectical philosophy. While we can only speculate as to what Engels meant to say in Dialectics of Nature, in another text, Ludwig Feuerbach and the End of Classical German Philosophy, Engels expresses a strikingly similar stance to Ollman, stating that:

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\text{The world is not to be comprehended as a complex of ready-made things, but as a complex of processes, in which the things apparently stable no less than their mind-images in our heads, the concepts go through an uninterrupted change of coming into being and passing away (Engels, 1947, [1888], p52, italics in original).}
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Engels also emphasises dynamism and totality. He adds that the major contribution of Hegel’s dialectical philosophy is that it: “reveals the transitory character of everything and in everything; nothing can endure before it except the uninterrupted process of becoming and of passing away” (Engels, 1947, p15). Elsewhere in the same text he comments on the achievements of 19th century biology while criticising its tendency towards “observing natural objects and natural processes in their isolation” (Engels, 1947, p27). Engels also rejects “dogmatic” interpretations of Hegelian dialectics, arguing that Hegel’s major contribution is his dialectical method rather than the content of his proposals (perhaps including the infamous three laws): “The whole dogmatic content of the Hegelian system is declared to be absolute truth, in contradiction to his dialectical method, which dissolves all dogmatism. Thus, the revolutionary side becomes smothered beneath the overgrowth of the conservative side” (Engels, 1947, p16).
In geography, dialectics is associated with urban theorists such as Soja and Merrifield and the potential contribution of a dialectics of nature is comparatively under-explored. However, as mentioned previously, Harvey uses examples from the natural sciences in order to illustrate his methodology. What does this mean for the question of the dialectics of nature? This final section will argue that the dialectics of nature debate is far from over. Indeed, it is at the heart of the ongoing schism among ecological Marxists about the kind of theory needed to make sense of socio-natures in the Anthropocene. This chapter has taken a detour through Engels’ attempt to elucidate a dialectics of nature in the late 19th century and the experiments in proletarian science in the 20th. However, some understanding of this history is necessary to make sense of ecological Marxism in the 21st century.

As the start of this chapter showed, Marx’s understanding of how different ways of organising human labour necessitate different relationships with the rest of the biosphere is foundational to ecological Marxism. Here it was also argued that ecological thought since Marx has tended to “see-saw” between naturalist and social constructionist positions, which are more or less aligned to materialist and idealist thought (Castree, 2000). As Marx and Engels were themselves influenced by both idealist and materialist ideas, perhaps it should not surprise us that their followers remain divided along such lines. Although we should be cautious about mapping contemporary debates too closely to these foundational differences between philosophical worldviews, some seem to find the idealism/materialism distinction relevant. For example, Foster seeks to defend a non-mechanical materialist Marxism and accuses his opponents of idealism.  

Castree argues that both naturalism and social constructionism fall prey to a dualism that presents a limit to our capacity to understand environmental questions. Both assume that nature and society are two distinct realms that come to relate to each other although they differ in which is seen as the explanatory pole (Castree, 2000). Therefore, what is needed is an approach that avoids either of these extremes and instead draws on Marx’s materialist outlook to show how any differentiation of humanity from the rest of the biosphere has arisen historically.

More recently, Shannon Brincat and Damian Gerber (2015) have advocated dialectics as just such a method. For them, a dialectical view is not just desirable but necessary in an era of biospheric instability: “it is only in moving toward a dialectical account of the totality…that we can begin to grapple with the accelerating ecological crises of the present” (2015, p873). Brincat and Gerber stress the dynamism of socio-natural systems and the opposition to dualism

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24 Foster and colleagues have consistently counterposed “materialist” science with spiritual or pseudoscientific accounts such as intelligent design. See Clark, Foster and York, 2007.
inherent in dialectical thought. Dialectics allows them to treat “society in nature” as a totality or dynamic whole and to avoid treating nature as external to human history; capitalism and its “crises” are for them inherently ecological. Such a method, will, according to these thinkers, enable us to critique specifically capitalist socio-natural relations rather than naturalising those relations and to seek out the potential for change within the conditions of the present.

Importantly, Brincat and Gerber (2015, pp872-875) see themselves as addressing an omission in Marxist theory in the 20th century. Marxism has lacked an appreciation of (what they call) the “affinity” between humanity and nature; so, nature needs to be reintegrated into dialectics in order to recover a more ecologically informed Marxism (Brincat and Gerber interestingly refer to their project as one of developing a “dialectical naturalism” to mean something like this, see p887, but naturalism can also have connotations of reducing socio-natural phenomena to supposed “natural laws” so the word is avoided here).

Similarly, Loftus (2012) takes “inspiration from Marx’s dialectical approach to understanding the world” for his project of rethinking environmental politics. As he argues, an approach drawing critically on Marxist dialectics can provide a framework “that is flexible enough to capture the interaction of what are normally conceived as separate elements: the natural and the social, the historical and the geographical” (Loftus, 2012, p.xvii). Following Smith’s example, Loftus demonstrates that, rather than being premised on a dialectical interaction between two separate elements—such as nature and society—a dialectical approach calls into question the historical processes through which these elements came to be seen as separate.

Paul Robbins also refers to dialectics as a key methodological influence within political ecology by including a section on “human—non-human dialectics” in his critical introduction (Robbins, 2012). Robbins’ interpretation of dialectics is similar to Ollman’s, it is a methodology that treats things as constituted by relations and as therefore existing “in a state of ongoing becoming…never the same thing at any time” (Robbins, 2012, p94).25

Continuing this project of revisiting a dialectics of nature, in a series of recent interventions, John Bellamy Foster has argued that only what he calls a “materialist dialectical” understanding of society and nature is adequate to grasp the implications of the Anthropocene. Foster understands dialectics as a theory of dynamics, complexity and transformation. He argues that ecological analysis must be rooted in “the recovery on a higher level, of the dialectics of nature—to be seen as connected to the dialectics of society”. This “is a vital task for Marxian ecological theorists today, who are seeking to explore the ecological

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25 This sentiment is arguably also evident in Robbins’ classic political ecology text Lawn People although he does not use the term dialectics in the book (Robbins, 2007).
contradictions of the Anthropocene, and to pave a way to a truly revolutionary praxis” (Foster, 2016, p23).

However, Jason Moore has raised some criticisms of the metabolic rift theory associated with Foster and others. Foster’s project of “connecting” a dialectics of nature to a dialectics of society is, according to Moore, a dualist approach. As Moore sees it, Foster has developed his analysis of capitalist political economy distinctly from his understanding of nature rather than addressing how capitalism and its crises develop through its production of nature (Moore, 2017b).

In the book *Capitalism in the Web of Life* (2015) and several related articles, Moore has made an ambitious attempt to rethink ecological Marxism and to develop a world-ecology. As Moore’s work is particularly influential, and particularly controversial, it is discussed in some detail here. Firstly, Moore proposes that ecological Marxism will be ineffectual if it rests on a dualism. Dualism as an ideology makes natures more commensurable to capitalist appropriation by enabling elements of the natural world to be quantified and rationalised. It can therefore only further capitalist interests: “The view of Nature as external is a fundamental condition of capital accumulation” (Moore, 2015, p2). According to Moore, the philosophical separation of humanity and nature in Western thought both underlies and bases itself in other dualisms including orientalism, binary understandings of gender roles and the oppression of indigenous people (often rendered as part of “nature” and cast out of the fold of “humanity”—Moore, 2017b, p289). This points to another of Moore’s contentions: that ideology matters (2015, chapter 8). He argues that practices of measuring and categorising non-human natures cannot be seen as distinct from the commodification and appropriation of those natures. Moore claims that some “left ecologists” have adopted a “vulgar materialism” that does not account for the role of ideology in shaping socio-natural relations (interview, 3 November 2016).

Rather than acting on nature, capitalism ought, according to Moore, to be seen as developing “through nature” in a continual process of mutual coproduction of humans and environments. Environmental history cannot be understood, therefore, by appealing to a combination of nature and society. Instead, transformations of social relations are also simultaneously transformations of space and nature (Moore, 2017b, p307).  

Secondly, Moore combines a version of Marxist value theory with a geographical approach to world history spanning the last few centuries. In terms of value theory, he maintains the classical Marxist position that it is the labour power of exploited workers that produces value

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26 Moore proposes new methods and new language, such as the notion of the oikeois in order to escape these persistent dualisms. The oikeois is described here as the “relation” from which other relations, including species-environment relations, emerge. The term originates with the Greek for “favourable place” that specifies a relationship between a species and its environment (Moore, 2015, p35).
Chapter 2: Ecological Marxism

in capitalism. However, he argues that unpaid work, including the “work” provided by non-human natures, is “appropriated”. The process of appropriation contributes to the formation of capitalist value as it makes labour power cheaper (Moore, 2015, pp143-148). For example, it might become cheaper to employ workers if they are able to harvest firewood for fuel themselves at no monetary cost; in Moore’s terms, accumulation relies on the appropriation of “unpaid work/energy” (p146). In this Moore owes some of his ideas to the social reproduction theories developed by Marxist feminists who draw attention to the role of unpaid human labour (for example by women in the home) in reducing costs for capitalists (Moore, 2015, p52). It is important to note here that Moore does not argue that nature is exploited; he makes a distinction between the “exploitation” of labour power and the “appropriation” of work beyond the capital-labour relation. Yet the two might be described here as two moments within the same process. Conversely, Richard Walker (2017) admires Moore’s work but argues that non-human natures are indeed exploited and that Marx was simply wrong to apply these terms only to human labour. On the other hand, Jean Parker (2017) criticises Moore for his inconsistency, arguing that although he states that only human labour power produces value, he tends to slip into referring to the “work” of non-humans as productive of value (see also Nayeri, 2016).

Moore argues that capitalism has, over centuries, reconfigured non-human nature. It is therefore more properly a way of organising nature rather than an economic system. This reorganisation, for Moore, does not in itself produce value but produces the relations that make the production of value possible. So, his interest is in uncovering the origin of the law of value rather than taking value relations as a given. Moore evocatively describes how capitalism has tended to open new frontiers of appropriation. From the 15th century onwards it scoured the globe in the search for fresh supplies of commodities such as iron, silver, timber and sugar (Moore, 2015 and 2017a). However, when the geographical limits of the globe were reached, exhausting the ability to appropriate new natures, capitalism escaped a crisis by cheapening inputs; creating cheap labour, cheap energy, cheap food and cheap raw materials. But capital is now struggling to restore these four cheaps and will imminently reach a crisis, perhaps even a terminal crisis, as it is difficult to see where the next expansion of ecological surplus will come from. For Moore, these periodic changes within capitalism as it seeks out new frontiers represent qualitative transformations or “shifts” in socio-natural relations rather than the break or rift that Foster might refer to (Moore, 2017b, p302).

Moore frequently refers to dialectics. He often quotes the (Western) Marxist philosopher Karel Kosik in saying that “dialectics does not consider fixed artefacts” (1976, quoted in Moore, 2017b, p285). For Moore (2015), such a methodology is necessary for his project. He also mentions the dialectical biologists Richard Levins and Richard Lewontin in his book (Moore, 2015, p46). Here he does not discuss their contribution to biology in great detail. However, in
an interview he described them as an early influence and “quite central” to his work and advocated that their 1985 book *The Dialectical Biologist* should be read as “a kind of methods text” (interview, 3 November 2016).

Moore refers approvingly to philosophies of internal relations and to Ollman and Harvey as influences. As well as dialectics taking “relationality to be its operative premise” and recognising historical movement he adds that a dialectical approach is based on asymmetry. So, it seems that, even for Moore, dialectics does invoke a relation between two moments, even if such moments are only temporarily held to be stable:

For dialectics you have to have a relation between two moments that are asymmetrical—[such as] capital and labour or empire and colony—and there has to be a historical movement such that the original terms of the relation, so capital-labour at the beginning…are eventually transcended. Not necessarily towards the expropriators being expropriated—that’s one possibility—but it could be another asymmetrical relation. So, you have to have the history, you have to have the asymmetry. And the history and the asymmetry mean you have to allow for the possibility of the interchangeability of subject-object relations. So, I mean those for me are the cores. Whatever basic units we begin with, whatever premises we begin with, we have to hold them stable up to a point, as Marx does of course for capital in the various moments of capital and the various other categories he uses. You have to treat them as historically stabilised but also as fluid in a particular trajectory (interview, 3 November 2016).

For Moore, however, even advocates of a sophisticated Marxist interpretation such as the metabolic rift theory adopt a “soft dualism” (2017b, p299) when they invoke a relationship *between* humanity and nature and talk of a rift in this relationship that must be healed. Such approaches are, for Moore, insufficiently dialectical if they are inattentive to the processes through which socio-natural relations develop: “Nature and society can only be a dialectic—as opposed to a relation—through a specification of their laws of motion” (Moore, 2017b, p295). However, he does not wish to dispense with metabolic rift thinking entirely. He notes that the original formulation of the metabolic rift approach (in Foster, 1999 and Foster, 2000) was rooted in an understanding of the processes of alienation of human beings from the conditions of their existence under capitalism. In other words, Foster initially recognised that human history could not be understood as distinct from natural history. However, the language of a “rift” has apparently been adopted by those who would more crudely emphasise a separation *between* society and nature or refer to society’s *impacts on nature*. Therefore, Moore claims he
wants to “affirm” the “dialectical core” of the original metabolic rift approach (Moore, 2017b, p287).

White, Gareau and Rudy (2016) also criticise Foster and other metabolic rift theorists, accusing them of assuming that nature exists in a state of balance or equilibrium when it is not disturbed by humans (2016, p27). These authors argue that rift theorists have failed to register work in non-equilibrium ecology that stresses the dynamism of biological systems. However, this particular critique is somewhat unfair. For example, Brett Clark and Richard York (2005a and 2005b) are two theorists in the metabolic rift tradition who have made use of dialectical biology to question the very assumption of a stable nature that human action simply impacts upon. However, it is true that they do at times refer to relationships between society and nature rather than adopting the language of hybrids or socio-natures that others might use (see chapter six).

Moore’s ideas have in turn been criticised by other Marxists. Part of the controversy relates to their political implications. Andreas Malm, who is sympathetic to the metabolic rift theory, takes issue with Moore’s “cheerful” assessment that capitalism will soon grind to a halt as its own contradictions become unmanageable, he points out that capitalism tends to find a way out of its problems by offloading them onto the working class rather than dissolving itself when it encounters a crisis (Malm, 2018, pp192-194). So, in the context of an ongoing debate about environmental “catastrophism”, it is argued that Moore does not take the scale of today’s environmental problems seriously enough. On the other side of the debate, overemphasising environmental destruction can make problems seem insurmountable and lead to pessimism and inertia among activists. For this reason, Harvey has in the past referred to Foster as dealing in “apocalyptic proclamations” and “doomsday scenarios” (1996, p195).

Malm also strongly criticises theories of the social construction of nature as, in effect, denying any real existence for biophysical processes. He posits a distinction between those who accept the reality of biophysical processes beyond human discourse, who acknowledge that “the actually existing forest contains a rich wildlife” and those who say it does not, dismissing the latter’s views as unhelpful in developing the theory needed to understand and respond to environmental problems (Malm, 2018, p27). Malm argues that theories of the construction of nature can be shown to be false “so easily as to court ridicule” (p36). As he sees it, there are many aspects of the natural world that predate human action. Coal, for instance, was laid down hundreds of millions of years ago. Therefore, it is simply incorrect to say that humans “produced” or “constructed” the coal seams, it is only relatively recently that they were encountered and manipulated by humans.
Foster has defended his own interpretation of the metabolic rift from accusations of dualism. Countering the argument that he separates economics from ecology in his work, he maintains that “a dialectical systems view…understands the ecological problem as simultaneously economic and ecological” (Foster, 2016c). Foster sees the dominance of social constructionist Marxisms as originating with the split between idealist and materialist Marxisms discussed above. As he notes, Lukács was influential in Western Marxism, which is characterised above all else by its rejection of a dialectics of nature, effectively placing all discussions of “nature” outside the realm of Marxist enquiry (Foster, 2016b, pp3, 20; Foster and Clark, 2016a). Foster argues that Lukács’ (initial) repudiation of the dialectics of nature lent the concept a problematic status in Marxist philosophy which it still retains: “It would be difficult to exaggerate the importance of this stricture for Western Marxism” (Foster, 2013). Foster argues that the influence of Western Marxism can still be seen today in what he terms “social constructionist” accounts of society and nature which he also conflates with philosophical idealism. These theories, he argues, are predicated on the idea that there is no nature outside of society.

Social constructionist ideas are dangerous, according to Foster, in that they downplay any analysis of the ways in which human societies emit waste into the biosphere (including the greenhouse gases that cause climate change, surely the pre-eminent environmental issue of our time). Whether Marxists treat nature as external or not, capitalism seems intent on literally and figuratively externalising its various waste problems. Therefore, while Foster accepts that socio-natural relations are in some sense internal, he also says that in a dialectical approach there needs to be a conception of the external relationship between society and nature (see also Holleman, 2015). This enables us to recognise the appearance of rifts in the metabolic process arising with capitalism which result from real processes of capitalist alienation of workers (Foster, 2016c). Similarly, for Malm, an issue like air pollution can only sensibly be seen as a problem of an external element (humanity) polluting the ecosystem rather than the problem being derived internally (Malm, 2018, p178).

Foster also sees Smith’s notion of the production of nature as exemplary of an idealist approach. He has argued that Smith comes close to denying that nature has any existence outside of society and is too quick to dismiss any discussion of the properties of the biosphere outside of human influence as “dualism”. Foster argues that for Smith “nature was seen as subsumed within society” (Foster, 2016b, p4). This is seen as a form of social determinism which is just as problematic as the reverse procedure, subsuming society into nature (environmental determinism). Similarly, Holleman argues that neither society nor nature can be reduced to the other: “Social history is not reduced to natural history nor is the rest of nature subsumed by society, social forces, and social meaning. [Dialectics] emphasises the need to
analyse the relationship between structure and process and change over time (communication by email, 3 January 2018). What is needed is an approach that holds both society and nature in tension and uncovers the dynamic interactions between them.

Foster concludes that there is a need to revisit the approach to science and nature developed within the Soviet Union, from the Eastern branch of Marxism where the dialectics of nature was not only remembered but enthusiastically adopted. Foster is critical of Soviet policy under Stalin and of Lysenko’s rejection of genetics. But he argues that some of the ideas of those Soviet scientists influenced by dialectics remains useful. As mentioned previously he is particularly interested in Vernadsky and the concept of the biosphere (Foster, 2016a).

However, Castree would surely disagree with Foster’s premise that the production of nature thesis is social constructionist. He has argued that instead it: “circumvents the absolutisms of either natural limits conservatism or social constructionist utopianism” (Castree, 2000, p28). For Castree, one of the advantages of the production of nature framework is that, rather than denying the existence of carbon dioxide, it allows for an understanding of the complex ways in which different environments are capitalised in historically and geographically specific ways. Furthermore, Foster’s dismissal of notions of the subsumption of nature appears to involve a misunderstanding. As discussed above, Smith uses the term “subsumption” to refer to a specific process, drawing on an analogy with Marx’s use of the same term in Capital. Here subsumption does not simply mean that one thing wholly disappears within or becomes contained within something else as Foster seems to imply. Instead nature is being transformed as it is subsumed. And surely, for Smith, it is capitalism that subsumes nature; the term subsumption refers to a real process, not a methodological preference on the part of Smith. Tellingly, Foster’s colleague Burkett also uses the term, referring to both labour and nature as subsumed under capital (Burkett, 2014, pp67 and 161).

Foster does indeed tend to overlook Smith’s work (along with much of environmental geography), conflating it with some quite different theoretical approaches, and seeing all as stemming from the same idealist distortion of Marxism. Therefore, Moore can complain with some justification that for Foster “all deviations from his interpretation of Marx are idealist and constructionist” (Moore, 2017b, 291).

As well as what he sees as the lack of a dialectical understanding evident in metabolic rift theories, Moore also sees another, related, problem with this work. He remarks that “socio-metabolic dualism has underemphasised the active role of extra-human natures in historical change” (2017b, p299). According to Moore, metabolic rift theories accord special status to human action and tend to treat the non-human world as passively responding to human action.
They treat humans as having the ability to “disrupt” the biosphere or create a rift in the metabolism of humanity and nature, while non-humans are not endowed with the same agency.

The production of nature has similarly been criticised for its lack of attention to the materiality of non-human nature. For its critics, the production of nature is “hubristic” and “insensitive to non-human agency” (see Loftus, 2017, p4). Recall that, for Smith, elements of the “natural” world are irrevocably drawn into the networks of human society; as they do so the properties of these things tend to become homogenised as they are turned into commodities with an exchange value (Swyngedouw, 2015, p137; Castree, 2003). Even an animal that seems free will be unable to exist outside of the bounds of human society—a shark’s meat and fins already have a price on the market as commodities that may or may not be realised. This perspective puts humans at the centre of the production of nature and emphasises the profound effect human activity has had in transforming the biosphere. However, Smith is quite aware of this. He argues that: “There can be no apology for the anthropomorphism of this perspective: with the development of capitalism, human society has put itself at the centre of nature, and we shall be able to deal with the problems this has created only if we first recognise the reality” (Smith, 2008, p8). Castree (2000, p30) further notes that Smith’s anthropomorphism is subtly different from anthropocentrism—which makes human activity its sole or pre-eminent concern—and argues that Smith was right to be “anthropomorphic” in his approach.

However, even critics sympathetic to Marxism have argued that a focus on human labour and its specific role in generating surplus value risks overlooking the “materiality of nature” (Castree, 1995, p13). Donna Haraway, for example, might add that the “encounter value” arising from interactions between humans and other species should be acknowledged in the Marxist framework alongside use value, exchange value and value (Haraway, 2008, chapter 2).

Also drawing attention to the material attributes of non-humans, in an analysis of the exploitation of the north Pacific fur seal in the late 19th century, Castree (1997) points out that the biological attributes of the seals (migration routes that crossed borders, suitability of the fur for making clothing and the large numbers of animals) offered an opportunity for hunting. However, the seals themselves also seemed to resist exploitation. Difficulties in identifying pregnant female seals meant they were often killed. This shocked commentators and influenced moves towards regulation of the industry. So, in this case, the material aspects of specific natural entities obstructed their complete transformation into commodities. Although nature can be said to be produced, with aspects of it being drawn into (in this case) industrial capitalism, nature doesn’t wholly disappear into capitalism (Castree, 1997, see also Henderson, 2009). As the following chapter will show, there is a growing interest among geographers in non-human agency and in the attributes of liveliness or vitality that might contribute to the monetary value placed on animals as they circulate as commodities (see
Collard and Dempsey, 2013). These criticisms have been particularly evident among those influenced by new or vital materialism. Chapter three will review recent work on the Anthropocene and show how, paradoxically as the Anthropocene seems to represent the triumph of human power, attempts to bring nature back in to discussions of socio-natures have become common in discussions of the proposed new epoch.

2.7: Conclusion

This chapter has demonstrated that ecological Marxists from a range of perspectives have called for a return of dialectical methods in making sense of socio-natural relations. Evidently, within the recent debates around approaches to ecological questions, divergent interpretations of what dialectics means play a central role. Employing a dialectical methodology involves more than merely an assertion that attention should be paid to the relations between things. Instead, dialectics is a coherent and distinctive philosophical worldview. It is a methodology with historical origins in Marx’s materialist transformation of Hegelian philosophy and understanding the origins of these ideas can aid us in understanding how dialectics might be understood today. However, as this chapter has also suggested, dialectics has sometimes been seen as obscurantist. This is not helped by references to “laws” such as “the law of the negation of the negation” with its determinist connotations and by examples of acorns “negating” oaks. Furthermore, Engels’ unfinished book *Dialectics of Nature* has also become associated with the tragic proletarian science project in the Soviet Union. Although Lysenko’s rise to power was a consequence of the political decisions of the regime as well as its dialectical materialist philosophy, some have argued that Engels’ formulations paved the way for the misuse of the dialectics of nature.

It might be argued that it is therefore unnecessary to invoke dialectics in discussions of ecology. Why not just do without such a philosophy? However, as Engels pointed out, everyone has a philosophy, those who don’t admit to it nevertheless have a philosophical basis for their views, often one that accepts the premises of the capitalist system. Therefore, there is a need to counter this implicit worldview with an alternative that explicitly emphasises dynamism, totality and contradiction. For Marx, the dialectical method was indispensable to understanding the relations that lie behind the appearance of the capitalist world he observed. And this applies equally to those trying to understand capitalism’s ecological relations as well as its political economy. Dialectics, rather than being superfluous, is central to a Marxist understanding.

The discussion of dialectics in this chapter has shown that it is an inherently politically engaged methodology, incomprehensible without also realising that dialectics is about changing the world, rather than observing it from the outside. It is a profoundly relational
ontology that seeks to understand a totality but employs a method (abstraction) for dealing with particular aspects of that totality in turn. Dialectics has at its core the idea that socio-natural relations can be changed. Furthermore, not all dialectical approaches rely on a rigid set of laws. The perspective developed by Ollman and popularised within geography by David Harvey and others offers an approach whereby, in essence, things are constituted by processes. This is distinguishable from mainstream or “bourgeois” philosophies but also avoids much of the dogmatism of earlier formulations of a dialectics of nature.

What role might dialectics play in ecological Marxism? As discussed in this chapter, it is by now more widely accepted that there is a need for a more ecological Marxism that engages not just with relations between people but simultaneously uncovers the consequent relations with the rest of nature. But there are several issues that have been and continue to be debated by Marxists. On the meta-theoretical level there is the question of whether Marx and Engels themselves were sufficiently ecological in their outlook or whether their work requires supplementing with ideas from environmentalist movements and thinkers. There are debates about the different types of human labour and about the forms of activity that do or do not contribute to what Marx referred to as value. And there are profound disagreements about how to conceptualise socio-natures; whether to adopt a radically monist approach or whether to conceptualise society and nature as existing in a relationship within which a rift has developed. These debates have their roots in the fundamental antagonism between social constructionist and naturalist perspectives that goes to the heart of any Marxist ecological theory.

In contemporary ecological Marxism, Jason Moore has usefully developed an understanding of the origins of capitalist value relations. Rather than naturalising capitalism, he has shown how the system, from its 16th century beginnings, has reorganised nature. His work is a corrective to accounts that treat society simply as an impact upon nature and he has shown how the ideology of an external nature has helped to facilitate its appropriation. Moore stresses the way that human activity transforms the biosphere. Rather than capitalism simply extracting materials from the “natural” world, historical change is seen as co-produced “by humans and the rest of nature” (Moore, 2015, p22). So, his ideas contrast with those of metabolic rift theorists, who tend to emphasise extraction from nature, especially the removal of nutrients from soil and its consequences for fertility. However, his critics are right to point out that Moore is shockingly optimistic about the prospects for the future, suggesting that ecosocialists should be more “hopeful” as they can expect capitalism to soon exhaust itself.

By contrast, the work of John Bellamy Foster, Paul Burkett and their followers emphasises how capitalism, for Marx, simultaneously degrades “the original sources of all wealth—the soil and the worker” (quoted in Foster, 1999, p379). Their work seems to be much closer to Marx’s understanding of a socio-natural totality as a differentiated unity than that of Moore
(who frames his intervention as an extension of classical Marxism). Here Nayeri raises the interesting point that Moore’s work, as it treats capitalism as a way of organising nature, focuses on an aspect of capitalism that it shares with other modes of production whereas the point of Marx’s work was to do the opposite, to address what is distinctive about capitalism (Nayeri, 2016).

Their approach allows the metabolic rift theorists to argue that humans are part of nature but also, by their conscious actions, simultaneously able to change nature as they change themselves. This corresponds to the emphasis Marx placed on the specificity of human labour in the references to nature in Capital, for example where he distinguishes between the ability to construct an environment of bees and architects. Smith is similarly anthropomorphic in his approach and, like Burkett, makes use of Marx’s value theory. Although metabolic rift theories have developed separately from critical environmental geography, Burkett’s and Foster’s positions are similar to Smith’s (and Marx’s) conception of a historically developing differentiated unity. Therefore, it is unfortunate that Foster has so readily dismissed Smith’s important work as “idealistic” and accused him of wanting nature subsumed into society. A more positive reading of Smith’s work might involve combining his broad approach with more concrete historical or empirical work on how specific natures become commodified and/or how they resist commodification as Castree (1997) does with the example of the fur seals.

As this chapter has shown, Lukács’ contention raises a genuine challenge to the dialectics of nature. If dialectical principles are relevant to our understanding of nature, they must be applied in a way that does not treat “nature” as external to human society. Lukács rightly points out that movement observed by a detached observer is no substitute for a dialectical method that is inherently critical. Thankfully, however, decades of work in ecological Marxism (of which only an overview has been possible here) have pointed to a way out of such a dualist approach. Furthermore, as will be demonstrated in later chapters, theorists from a range of perspectives have questioned whether “agency” or subjectivity is purely a human attribute as Lukács seems to imply. As Marxists have sought theoretical tools to make sense of what is now increasingly referred to as the Anthropocene, the old debate about the dialectics of nature deserves to be revived.
Chapter 3: The Anthropocene and the new materialisms

The introduction to this thesis referred to the profound influence of human activity on Earth system processes. As this chapter explains, this human influence is increasingly understood as representing a shift of global scale and significance, leading to calls to rename the current geological epoch the “Anthropocene”. As will be explained, the Anthropocene raises questions about the relationship between humans and (the rest of) nature, the way this relationship has shifted throughout history, the role scientists might play in progressive politics, human “nature” and the roles of human and non-human agency in the biosphere. As ecologist Erle Ellis has argued, what is needed now is to make sense of the historical processes through which humans have become a geological force (Ellis, 2015).

As the previous chapter demonstrated, ecological Marxism has engaged with many of these questions since Marx and Engels’ own writings. Marxism is concerned with understanding human societies and their consequent relation with nature and with uncovering shifts in that relationship throughout history rather than naturalising the current state of things. Some Marxist thinkers, including Foster, have consequently embraced discussions of the Anthropocene (see Foster, 2016a). However, others have been more sceptical, at least about the implications of certain narratives of the Anthropocene (Malm and Hornborg, 2014). The idea of an epoch of humanity’s own making has been criticised for the abstract and paradoxical approach some of its advocates take towards the issue of human agency and in some cases for reliance on an idea of a fixed (and essentially destructive) human nature. But the new epoch has been of particular interest to theorists influenced by new or vital materialisms. For Jamie Lorimer, whose multinatural approach will be discussed later in this chapter, the Anthropocene is capable of delivering a “necessary shock to environmental thought” by finally eradicating the ideal of a nature distinct from human history (Lorimer, 2015, p3). For Lorimer, the

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27 Geologists divide up historical time into eons, eras, periods, epochs and ages. The present eon is the Phanerozoic, the era is the Cenozoic and the period, the quaternary. The quaternary is conventionally divided further into two epochs: Pleistocene and Holocene.
Anthropocene is still useful as a concept, despite the problems with some interpretations. Although, as discussed in the previous chapter, Marxist thinkers have long challenged the view of an external nature, thinkers such as Lorimer sometimes frame their work in opposition to Marxist dialectics.

The term Anthropocene in its modern iteration was first proposed in the year 2000 by the Nobel Prize winning atmospheric scientist Paul Crutzen and by freshwater biologist Eugene Stoermer (Crutzen and Stoermer, 2000). In 2004 Will Steffen and colleagues at the International Geosphere-Biosphere Programme added to the evidence for the Anthropocene with their report, *Global Change and the Earth System*. The IGBP developed Earth system science as an approach that itself treats the planet as a single complex system with multiple interacting elements in which living things, including humans, play an active role:

> Crucial to the emergence of this perspective has been the dawning awareness of two aspects of Earth System functioning. First that the earth itself is a single system within which the biosphere is an active, essential component. Secondly, that human activities are now so pervasive and profound in their consequences that they affect the earth at a global scale in complex, interactive and apparently accelerating ways (Steffen et al, 2004, p1).

By 2009 a working group of the International Commission on Stratigraphy (the body responsible for designating geological time periods) was set up in order to assess whether the Anthropocene can be formally added to the geological timescale. For this to happen, there would need to be a clear marker for the start of the epoch such as a measurable change in lake sediments or the composition of Arctic ice. For the working group, there is substantial evidence for the fact of the Anthropocene. According to the website of the Anthropocene Working Group: “it is widely agreed that the Earth is currently in this state” (Anthropocene Working Group, 2018).

For Crutzen and Stoermer, the designation of the Anthropocene means that humans are likely to “remain a major geological force for many millennia, maybe millions of years, to come” (Crutzen and Stoermer, 2000, p18). They note that human influence is present in all planetary processes, whether biological, atmospheric or geological. It is evident at a molecular level in the increased levels of carbon dioxide in the very air we breathe (Marris, 2011). Human

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28 As mentioned in the previous chapter, similar ideas were developed by scientists in the Soviet Union. Aleksei Pavlov and Vladimir Vernadsky both developed an understanding of the role of human agency in environmental transformation similar to theories of the Anthropocene today. The Holocene epoch was described in other early geology manuals as the “anthropozoic” and the “age of mind and era of man” (Lewis and Maslin, 2015).
agency has, in other words qualitatively transformed the biosphere, switching from extensively pushing out to appropriate more of nature to having an intensive influence on Earth system processes (see Castree, 2000, p25 for this distinction).

The term Anthropocene, derived from the Greek “Anthropos” (meaning human being) and “kainos” (recent) suggests that most of the artefacts hypothetical future geologists might find by examining sedimentary rock layers or ice cores would be of recent human origin (Bonneuil and Fressoz, 2017, pp3-4). Such artefacts might include the bones of domesticated chickens. Chickens have grown in number since the mid-20th century, becoming the world’s most populous bird with around 60 billion animals killed each year. The fossilised chicken bones would also be distinguishable from those of their wild ancestors, for example by being bigger in order to support the weight of an animal bred to produce more meat (Carrington, 2016).

Ellis has coined the term “human climate” to describe the ongoing directed effect human activity is having (as opposed to human weather which refers to short-term human-environment interactions). He refers to “anthropogenic biomes”, large areas of Earth’s surface with characteristics consistent with human influence in the same way that biomes are traditionally designated to reflect different climatic conditions (interview, 23 August 2016; Ellis, 2015; 2016).

Since it was first coined, the term Anthropocene has spread far beyond the small group of natural scientists tasked with its official designation. As Castree notes, social scientists are taking a belated but increasing interest in the idea and are continuing to debate its consequences (Castree, 2014). Lövbrand and others (2015) have effectively argued that the Anthropocene is too important to be left to the natural scientists. More engagement by social scientists might extend what they see as a “restricted” narrative offered by the physical sciences and incorporate a greater understanding of the cultural and political dimensions of global change. In what follows, this chapter reviews some of the most popular proposals for an Anthropocene start date. The chapter goes on to discuss some of the more problematic narratives attached to the proposals for a new epoch. It explains why, consequently, some theorists such as Andreas Malm have been sceptical about the Anthropocene before showing how others from the new/vital materialist tradition have found the idea of an Anthropocene epoch useful, despite the evident problems with some interpretations.

3.1: When did the Anthropocene begin?
For the Anthropocene to be designated a new epoch, it would need to represent a shift in environmental conditions on a global scale. “What matters when dividing geological-scale time is global-scale changes to Earth’s status, driven by causes as varied as meteor strikes, the
movement of continents and sustained volcanic eruptions” (Lewis and Maslin, 2015). Boundaries between geological time units have often involved rapid changes in the type of living species on Earth as well as signatures in the rock strata. For example, the start of the Cenozoic era was marked by a dramatic loss of species including extinction for all the non-avian dinosaurs (the K-T extinction). As well as changes in the fossil record, geologists prefer to establish an internationally agreed upon reference point known as a Global Boundary Stratotype Section and Point or “golden spike” that acts as a marker of the boundary between one geological time period and another. A peak in the levels of the element iridium found in the rocks at El Kef, Tunisia, consistent with the idea that a meteor hit Earth at this time, provides a geological marker for the start of the Cenozoic. The golden spike need not represent the most important thing that happened at the boundary between time periods, it simply serves as a marker that geologists can agree on (Lewis and Maslin, 2015).

With these criteria in mind, various proposals for an Anthropocene start date have been put forward, including the origin of agriculture, the “discovery” of the new world, the Industrial Revolution or even as recent as the middle of the 20th century (Lewis and Maslin, 2015). All of these proposals for a start date represent significant events in human history with associated qualitative shifts in socio-natural relations. For many the start date has been a key question. Assessing what point in history human activities became so pervasive is clearly important for those concerned to understand the reasons for this shift.

One proposal is that the Anthropocene actually began around 11,700 years ago after the end of the last ice age, which by convention we currently think of as the start of the Holocene (so Holocene could be renamed “Anthropocene” or geologists could keep the existing terminology and make no distinction between human influence in the Holocene and more recent influence). Other proposals for an “early Anthropocene” push the start date back even further in time, to when humans caused the extinction of many large mammals or even to the first surviving evidence of any human activity. An early start date would reflect the fact that the human species has always, by necessity, lived in a complex and developing relationship with the biosphere; which Foster might describe as a metabolic relationship. Humans have been domesticating animals and crop plants for thousands of years and have therefore influenced the evolution of other species. Agriculture, and emissions from livestock and forest clearing, have had an effect on the planet’s temperature from early in the Holocene and may have prevented the global cooling that would otherwise have occurred (Zalasiewicz, Williams, Steffen and Crutzen, 2010).

A contrasting proposal from Mark Maslin and Simon Lewis that teases out the role of colonialism in large-scale biospheric transformations, is that the Anthropocene started with the first contact between the new and old worlds after 1492. From this point, humans introduced
crops such as maize and potatoes to Europe, Asia and Africa and transported wheat and sugarcane to the Americas causing significant and irreversible changes to ecosystems. These changes occurred all over the world and can be detected by identifying the appearance of new types of fossilised pollen. Of course, the “discovery” and conquest of the Americas brought slavery, famine and disease to many of the people living there. The human population declined from an estimated 54 million to 6 million by 1650 (Harman, 1999, p171). With fewer people to farm the land, forests started to return and levels of carbon dioxide in the atmosphere dipped. The reduction in carbon dioxide level (it reached its lowest in 1610; a nadir known as the Orbis Spike) could further serve as a geological marker for this event as it can be detected in Antarctic ice (Lewis and Maslin, 2015). The Orbis Spike hypothesis therefore integrates an understanding of imperial conquest into theories of when humanity became a significant global force.

While Lewis and Maslin’s Orbis Spike proposal incorporates changes to ecosystems and human populations, Crutzen and Stoermer themselves focused more narrowly on energy use and greenhouse gas emissions. They initially suggested that the Anthropocene may have begun towards the end of the 18th century when James Watt developed the steam engine (Watt patented the condensing chamber that allowed large engines to be built by 1769). It was around this time that, according to Crutzen and his colleagues, atmospheric greenhouse gas concentrations started to rise (Crutzen and Stoermer, 2000). So, whereas for most of the Holocene levels of carbon dioxide in the atmosphere had fluctuated—going up or down by up to 5 parts per million (ppm), since the Industrial Revolution carbon dioxide levels have been rising by 2ppm per year (Malm, 2016). Crutzen and Stoermer also propose a “great acceleration” around the middle of the 20th century—a “remarkable explosion” in which the levels of carbon dioxide in the atmosphere have begun to shoot up even more rapidly (Steffen, Crutzen and McNeill, 2007).

Finally, some have proposed that, rather than the middle of the 20th century representing an acceleration within the Anthropocene, the epoch actually started in 1945 (Zalasiewicz et al, 2015). The first nuclear weapons test (and of course the first usage of nuclear weapons in war) took place in this year and testing continued throughout the 1950s and 1960s. This proposal has the advantage of providing a basis for a golden spike as there is a clear peak in the levels of carbon isotopes from nuclear weapons in tree rings around this time and it is unambiguous that this was caused by human activity (Lewis and Maslin, 2015). As with the iridium deposits that mark the start of the Cenozoic, this does not mean that nuclear weapons testing was the most significant thing that happened in the mid-20th century. To be considered the

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29 1945 is, of course, extremely recent for geologists accustomed to dealing with time periods of hundreds of thousands of years and to referring to 1950 as “the present”. 
start date of the Anthropocene it would merely have to represent a time in which a profound shift in human societies and a related impact on planetary processes occurred. For Will Steffen and others this is indeed plausible:

The second half of the twentieth century is unique in the entire history of human existence on Earth. Many human activities reached take-off points sometime in the twentieth century and have accelerated sharply towards the end of the century. The last 50 years have without doubt seen the most rapid transformation of the human relationship with the natural world in the history of the species (Steffen et al., 2004, p258).

A recent paper by the Anthropocene Working Group favoured a mid-20th century start date: “a pronounced, relatively sharp threshold in human modification of the global environment” (Zalasiewicz et al., 2015). In summer 2016 the group’s 35 members voted overwhelmingly that the Anthropocene is stratigraphically real and should be formalised. Furthermore, there were 28.3 votes for a start date around 1950,30 far more than for any other start date proposal such as the Orbis Spike and earlier potential start dates. Plutonium fallout was the most popular choice of primary signal. There will need to be further votes on these proposals by the group’s parent bodies and they are still in the process of locating a suitable golden spike (Anthropocene Working Group, 2016). However, although the group do recognise that humans have left an impact on the stratigraphic record since before the start of the Holocene, the majority now agree that this influence intensified around the mid-20th century to such an extent that this point can be seen as the end of the Holocene.

Members of the Anthropocene Working Group have pointed out that the period since the Second World War has involved rapid population growth, urbanisation, the intensification of agriculture and the widespread adoption of consumer goods such as televisions, cars and fridges. A marked increase in the adoption of disposable packaging at this time is just one example of the environmental consequences of the shift. This is often illustrated with various graphs that appear to show a notable upturn in the middle of the 20th century. As Bonneuil and Fressoz (2017, pp53-54) point out, however, we ought to be cautious in interpreting these graphs. An exponential curve, by definition, becomes increasingly steep and can sometimes appear to the eye to turn upwards sharply in the middle even when the rate of growth is actually constant.

However, even if the graphs alone are ambiguous, some have suggested that there was indeed a qualitative global shift in socio-natural relations around the middle of the century. Drawing

30 One member appears to have split their vote 3 different ways.
on theories of monopoly finance capital, ecosocialist Ian Angus highlights the dominant economic position of the United States following the Second World War and the growing role of large monopolies (as opposed to smaller capitals) in the global economy, demonstrating the consequences of this for the biosphere (Angus, 2016, pp137-145). Therefore, Angus favours the idea of a “great acceleration” in capitalist influence on the biosphere in the mid-20th century which broadly aligns with his economic perspective. Angus would remind us that capitalism itself is a dynamic system that has gone through major changes in its short history. As well as developing an understanding of the workings of capitalism in the abstract, theorists ought also to analyse the specific ways in which the system has developed and changed.

Bonneuil and Fressoz (2017, pp144-147) also point to the role of the Second World War and the associated increase in industrial production (especially in the US) and rapidly increasing levels of energy consumption.

Discussions among geologists about when the Anthropocene began may seem like academic diversions. However, differing views on this question have real consequences for how we interpret the causes of environmental problems. Advocates of the various early Anthropocene hypothesis have been criticised for “normalising” global environmental change (Lewis and Maslin, 2015). By arguing that the biospheric instability of today has its roots in the emergence of human civilisation, they tend to downplay the dangerous effects of climate change and the speed with which it has come about. This interpretation arguably loses the power to shock that is one of the intriguing things about the Anthropocene diagnosis in the first place. Angus even supposes that these views are being promoted by lobbyists associated with the eco-modernist Breakthrough Institute. Although some environmental thinkers are associated with the Breakthrough Institute—Paul Robbins is a Senior Fellow—Angus argues that the Institute have opposed measures that would reduce carbon dioxide emissions and have offered technological, pro-capitalist measures such as nuclear power as the only potential solutions to climate change. He therefore refers to them as having an “anti-environmental agenda” (Angus, 2015b).

By contrast, a mid-20th century Anthropocene start date clearly invokes an accelerating influence of human activities on Earth system processes. Rather than an extension of the Holocene, it marks a departure from this epoch. The Holocene, characterised by a temperate and relatively stable climate, is associated with relatively conducive conditions for human survival (Swyngedouw, 2015, p131). It is the time period in which agriculture was established and that allowed for complex, urbanised human societies to develop. Although Holocene conditions always involved climatic instability, particularly for those most vulnerable to droughts or extreme weather, for thinkers such as Angus the Anthropocene represents a new epoch of unpredictable and dangerous climatic conditions (Angus, 2016).
3.2: The Anthropocene paradox

The implications of the Anthropocene for environmental theory are profound. However, it has been interpreted in divergent ways by different commentators. As explained in chapter two, environmental thought has sometimes treated human activity as external to nature. These ideas have also prevailed in discussions of the Anthropocene with some using language that implies that humanity, as a whole, impacts upon nature (with the implication that humanity should therefore collectively lessen its impact—Lorimer, 2015, p5). For example, Will Steffen and his co-authors refer to “great forces” of nature which are now supposedly being “overwhelmed”: “human activities have become so pervasive and profound that they rival the great forces of Nature” (Steffen, Crutzen and McNeill, 2007). Crutzen (2002, p23) is clear in highlighting a rapidly increasing human population as a source of impact upon the planet: “The rapid expansion of mankind in numbers and per capita exploitation of Earth’s resources has continued apace”.

These same authors even state that “Earth has now left its natural geological epoch” which tends to imply that the planet was in a pristine state before the onset of the Anthropocene. As these ideas of humanity destroying or overwhelming nature have been dominant for centuries it is hardly surprising that human agency has been pitted against the “forces of nature” in some discussions of the Anthropocene (Moore, 2017b, pp288). Of course, Anthropocene scientists are aware of the extensive human manipulation of the biosphere before the middle of the 20th century. Few would state explicitly that the natural world remained untroubled by human influence up until recently. The scientists also rightly point to what seems to be a qualitative shift in socio-natural relations taking place in the mid-20th century. However, statements about leaving a “natural epoch” remain problematic. The implication of an undifferentiated humanity acting on an external nature diverges from the understanding of social relations and the role of capitalism in producing nature discussed in the previous chapter. Furthermore, the notion of leaving the natural epoch suggests that the Anthropocene emerged from nowhere and does little to historicise this apparent epochal shift, explaining how or why the shift took place at the particular time it did. To understand the shift there is a need to understand the processes leading into it.

Mainstream Anthropocene narratives have also been associated with problematic assumptions about human nature. They have sometimes involved the assumption that there is something inherently destructive about humans and that the emergence of the Anthropocene was therefore inevitable. If environmental damage is caused by something essential to “human nature”, it follows that all humans are implicated in this to some extent; and, as there is little that can be done to change what is essential to human nature, drastic measures (such as geoengineering) may be needed to fix the problem. For some proponents of the standard
Anthropocene narrative, humanity’s ability to use fire has led us to manipulate the planet like no other species. Some have even proposed to label the human species “the fire-ape”, *Homo pyrophilis* (Mark Lynas quoted in Malm and Hornborg, 2014, p63). For these thinkers, the use of fire led in a linear progression to a situation where humans would at some point learn how to extract fossil fuels and would inevitably end up burning those too. This kicked off a chain of events that led to a rapid expansion in fossil fuel use and the skyrocketing carbon emissions observable today. According to one scientific paper: “The mastery of fire by our ancestors provided humankind with a powerful monopolistic tool unavailable to other species that put us firmly on the long path towards the Anthropocene” (Steffen, Crutzen, and McNeill, 2007; see Malm, 2015, for a critique of this thinking). Simon Lewis has even argued that the designation of the current epoch as the Anthropocene represents a shift in the way humanity sees itself. Copernicus demonstrated that humans are no longer at the centre of the universe and Darwin’s theory of evolution displaced humanity from the top of the tree of life. But now: “the future direction of the only place in the universe where we know life exists is in our hands. Suddenly, after almost 500 years, humanity is centre stage again” (Lewis, 2009).

However, this is a long way from the sophisticated approach to human nature to be found in the work of Marx and Engels. The subject of human “nature” will be discussed further in chapter seven of this thesis with reference to the findings of the dialectical biologists. But, to put it briefly, although Marx does not deny the existence of a human nature, that nature is seen as developing historically as a result of the ways in which humans manipulate their surroundings which, in turn influences their own development as a species. As human nature is not fixed, it implies that environmental problems arise as a consequence of the ways in which humans are organised in a capitalist society rather than as a result of some essential property of humans.

Ellis points out that *Homo sapiens* is not the first species to have altered its external environment—the atmosphere was changed dramatically by the addition of oxygen following the evolution of green plants, for example. But the speed and scale of change resulting from the action of a single species, humans, is “unprecedented”:

> My biggest question as an ecologist is “why do you have a single species changing the earth so much?” There is actually no precedent for that. It’s a remarkable thing. There are some examples...of where organisms, groups, taxa have had that kind of role. Photosynthesis has changed the earth powerfully, more powerfully than we are, but it wasn’t one species and it took hundreds of millions of years. It’s a whole other thing, it’s a strange thing that one species would do this. And it’s obviously not related to our biology directly. People didn’t have the capacity to interact with...
each other at large scales that could actually influence the world in general until relatively recently. So, what is interesting to me is why did humans get this capacity to do this? And I see that as the cause of the Anthropocene (interview, 23 August 2016).

As Kay Anderson has pointed out, the standard Anthropocene narrative described here involves a paradox (Anderson, 2014). Humans seem to have more agency than ever before. For the first time in history humanity is seen as capable of pushing the whole planet into a new epoch; we are in the driving seat in a way we have never been before even though it seems we are intent on crashing the train. This type of thinking has also been described as a form of human exceptionalism—“the positing of a separation between active human subjects and passive non-human objects” (Anderson, 2014, p5) in that humans are seen as unique in their ability to manipulate the environment.

However, it is also assumed that humans have very little agency actually to change the situation, faced as we are with the prospect of unleashing global forces that we have little power over. At the same time as humans are supposedly overwhelming the forces of nature, humanity itself is also a force of nature; the Anthropocene is therefore seen as simultaneously both a natural and an unnatural phenomenon (Lövbrand et al, 2015. Moore, 2017a). As with many of the interpretations of the Anthropocene discussed here, this paradoxical approach builds on existing ideas. Even before the widespread contemporary discussions of the Anthropocene, Neil Smith recognised this paradox in his description of “nature-washing”, noting how it is widely acknowledged that climate change is anthropogenic, but that the resulting biospheric instability is nevertheless seen as being caused by the “power” of “nature” (quoted in Swyngedouw, 2015, p139).

Furthermore, and related to the previous point, Erik Swyngedouw refers to the post-political nature of discussions around climate change (Swyngedouw, 2015; 2018), an analysis that has also been applied to the Anthropocene specifically (see Lövbrand et al, 2015). As Swyngedouw (2018) points out, there is a consensus among almost all scientists and much of the public about the causes of anthropogenic climate change and the magnitude of the situation. Climate change has become a matter of public debate and discussion. But, precisely because climate change is viewed as a problem for the whole of humanity, this has resulted in a process of de-politicisation where no particular political programme is advocated. Ideological contestation around different possible socio-ecological futures has been displaced by forms of technocratic governance that naturalise those solutions compatible with a liberal worldview such as market-based measures and changes to individual behaviour (Swyngedouw, 2015, p136). It seems that, in the face of an overwhelming threat, the proximate causes of which (ie carbon dioxide emissions) most people can agree on, only mutually agreeable
solutions are put forward: “the space for political contestation, debate and reorientation is…restricted” to very narrow considerations such as the right type of technology to adopt and when (Lövbrand et al, 2015, p214). With the dominance of post-political narratives there is no corresponding political subject (such as the proletariat for Marxists) as this tends to be replaced by broad appeals to “the people”, or perhaps the “Anthropos” (Swyngedouw, 2015, p140).

Related to the post-political narrative is the idea that the Anthropocene is “good” or “great” and is something to be embraced. Ellis’ comments on the causes of the Anthropocene have been discussed above. He has also become associated with the good Anthropocene idea, stating that humans have become such an overwhelming causal agent that: “In moving toward a better Anthropocene, the environment will be what we make it” (quoted in Collard, Dempsey and Sundberg, 2015, p324). For Ellis this comes to be tied to the idea that humans have uniquely developed the capacity to “wake up” to the negative effects “we” are having. Humans merely need to put the newfound knowledge of the Anthropocene to good use:

The boom in Anthropocene discussions might itself indicate that societies are waking up to the realities of becoming a global force in the Earth system...we might guide this new “great force of nature” toward better outcomes for both humanity and nonhuman nature. It is time to embrace what makes us human, ultrasociality, and turn it towards the grand challenges of the Anthropocene—to intentionally build better societies and cultures of nature (Ellis, 2016).

However, Bonneuil and Fressoz, in one of the most insightful chapters of their book *The Shock of the Anthropocene* take issue with this idea that “our generation is the first to recognise environmental disturbance” (Bonneuil and Fressoz, 2017, p170). Actually, previous generations were also aware of the role of human activity in modifying their surroundings. They give examples from the 18th and 19th centuries of different forms of environmental reflexivity and debates over the nature of “environment” and reactions to resource scarcity, including Vernadsky’s concept of the biosphere. For these authors, treating earlier societies as inadvertently heading down a path of environmental destruction depoliticises these discussions. Instead, the biosphere has been an area of political contestation for at least the last three centuries (Bonneuil and Fressoz, 2017, pp171-172).

Advocates of the idea of a good Anthropocene, who offer an “optimistic vision” of a future society founded on increased use of technology, have tended to see the new epoch as an opportunity to utilise the ability to manipulate nature that humans now seem to possess. Among advocates of the good Anthropocene, as with post-political narratives generally, there
is often little discussion of who will be responsible for implementing all the proposed technological innovations. Paul Crutzen, one of the originators of the Anthropocene terminology, seems to assume that it will be the “scientists and engineers” who will “guide society towards environmentally sustainable management” (Crutzen, 2002).

Perhaps unsurprisingly then, Crutzen has suggested that high-tech geoengineering solutions might be needed to solve climate change and favours a strategy of trying to cool the climate by firing sulphur into the air (Connor, 2006). Space here does not allow for a full discussion of the arguments around geoengineering. However, one criticism of this approach is that, even if one of the various proposals actually works (by no means guaranteed), it would address the symptoms but not the ultimate social cause of climate change. Cooling the planet down would not solve any of the other multiple environmental problems beyond global warming and would almost certainly have its own negative consequences. A more immediate concern is that, as climate scientist Kevin Anderson has pointed out, the promise of possible geoengineering fixes in the future can feed into political inaction today. For Anderson, the targets for greenhouse gas reduction set at the UN talks in Paris in 2015 were not as radical as he hoped; they were premised on the idea that humanity would, at some point, come up with a way of sucking carbon dioxide out of the air. Geoengineering may therefore have gone from being a “last ditch Plan B” to part of the only plan (Anderson, 2015).

3.2.1: Malm’s critique
Reading these mainstream narratives of the Anthropocene, it is not hard to see why some Marxist commentators have been suspicious of the concept. Capturing some of these criticisms, Andreas Malm has referred to the “Anthropocene Myth” (Malm, 2015). He pursues a similar line of reasoning to Bonneuil and Fressoz by refusing to naturalise climate change, although he seems more dismissive of the Anthropocene argument in its entirety than these authors.

Malm has shown how climate change has historical roots in the actions of a small group of wealthy British people during the Industrial Revolution. It is neither caused by humanity as a whole, nor does it affect humanity equally (Malm, 2016). Returning to Crutzen’s suggestion that the Anthropocene began with the invention of the steam engine and the associated increase in fossil fuel use, Malm offers an important counter-narrative to the assumption that this was a direct result of humankind’s earlier mastery of fire. He points out that Crutzen and his associates do not say a lot about the political processes that led to the adoption of steam power in Britain around the 1830s. Addressing this omission, Malm argues that steam engines were not technologically superior to alternative forms of technology such as the water wheel.
In fact, for an individual factory owner, buying coal was the more expensive option. However, coal did offer several other advantages for the capitalist; it provided a regular supply of energy, it didn’t require different capitals to band together and invest jointly in infrastructure in the way that water power did and it could be used at a convenient time of day. Perhaps most centrally, steam power brought industrial production into cities like Manchester. Cities increasingly provided a plentiful supply of cheap and exploitable labour power and, according to Malm, it was hoped that workers in urban areas would be more easily forced to accept the discipline of factory life (Malm, 2016). Note that, according to this narrative, steam power was “presupposed” by an early capitalist system in which a small minority owned the means of production and much of the rest of society were being drawn into wage labour:

While it is admittedly banal to point out, steam engines were not adopted by some natural-born deputies of the human species. The choice of a prime mover in commodity production could not possibly have been the prerogative of that species, since it presupposed, for a start, the institution of wage labour. It was the owners of the means of production who installed the novel prime mover (Malm, 2015).

Therefore, Malm’s work, as well as addressing debates around the Anthropocene is also a critique of technological determinist arguments (including among Marxists) — where it is assumed that changes in technology prefigure social changes — in favour of an account that sees changes in energy use as contingent rather than necessary. For example, Malm takes issue with the work of the philosopher GA Cohen, who assumed that newer technologies tend to be superior to older technologies and that, once adopted, new technologies have the power to reorganise social relations (Malm, 2016, pp32-35).

Central to Malm’s argument is the idea that climate change is political, and the adoption of coal came about as a result of class struggle. In this particular struggle it was the emerging capitalist class who were able to implement their chosen technology at the expense of workers (and in the face of resistance from workers). Malm, like Bonneuil and Fressoz, concludes that the Anthropocene was brought about consciously. Factory owners in the 19th century could not have understood climate change as we understand it today. But they nevertheless deliberately took action to shift to burning fossil fuels. This shift didn’t happen as part of some natural process of human evolution.

Another point that follows from Malm’s general line of argument is that, of course, humans are not equally responsible for the burning of fossil fuels. To this day energy use depends to an overwhelming extent on the type of society a person lives in. The energy consumption of an
average Canadian is 1,000 times greater than that of a typical farmer in the Sahel and overall, the poorest 45 percent of humanity generate just 7 percent of the carbon emissions (Malm, 2016, p269; Malm and Hornborg, 2014). Of course, the scientists currently debating the start date of the current epoch do accept this argument. Crutzen himself has argued that anthropogenic climate change has “largely been caused by only 25 percent of the world population” (Crutzen, 2002). After receiving some criticisms (including from social scientists), further work has been produced that differentiates between humans based on whether they live in rich or poor countries (see Steffen et al, 2015) although this is not the same as the historical and class analysis of the ultimate roots of the problem that Malm might advocate.

There is much to agree with in Malm’s arguments. It makes sense to try to repoliticise climate change and to question essentialist views of human nature or linear historical narratives. It is also worth noting here that Malm’s argument is not necessarily a critique of the word Anthropocene per se. What he objects to is a particular narrative associated with its use. But equally it is fair to say that he is sceptical about how useful it would be for Marxists to take up the term Anthropocene. Referring to the tendency for Anthropocene narratives to flatten differences in influence between different humans, he has described it as “an indefensible abstraction at the point of departure” (Malm, 2016, p391). However, several commentators, including Marxists, have argued against dispensing with the term. Much of Malm’s argument hangs on a critique of Crutzen and of a few others who sometimes say problematic things, and it seems premature of Malm to associate the Anthropocene so closely with the Industrial Revolution, especially now this that start date is unlikely to be formally accepted and mid-20th century dates are increasingly discussed.

Malm, together with Alf Hornborg, also complains that discussions of the Anthropocene have been dominated by natural scientists and are therefore “the illogical and ultimately self-defeating foray of the natural science community…into the domain of human affairs”. He argues that such people “extend their worldviews to society” and that “geologists, meteorologists and their colleagues are not necessarily well-equipped to study the sort of things that take place between humans” (Malm and Hornborg, 2014, p66). However, as evidenced in the previous chapter, Marx and Engels themselves would not have been so dismissive of the insights of scientists in their own time. In contrast to Malm, Angus argues against “carping from the side-lines about the scientists’ lack of social analysis”, and calls for a synthesis of insights from Earth system science and ecological Marxism: “ecosocialists need to approach the Anthropocene project as an opportunity to unite an ecological Marxist analysis with the latest scientific research in a new synthesis—a socio-ecological account of the origins, nature, and direction of the current crisis in the Earth system” (Angus, 2015a).
There is also a more fundamental argument to be raised against Malm’s ontological approach. He tends towards explaining historical developments in terms of class struggle between one group of humans and another where the most powerful group will win out (an approach that could be described as class struggle determinism in contrast to technological determinism). This examination of what happens between humans gives very little emphasis to the way human societies develop in a relationship with the rest of nature. Indeed, as discussed at the end of this chapter, Malm has more recently developed a defence of dualist thinking about society and nature (especially in Malm, 2018). Jason Moore, who, as we have seen, argues that capitalism develops through nature in a relationship described as a double internality, has sharply criticised Malm’s thinking, pointing out that “human activity not only produces biospheric change, but relations between humans are themselves produced by nature” (Moore, 2017a; see also Moore, 2015). Moore consequently argues that the origins of the epoch should be traced to profound shifts in socio-natural relations beginning as far back as the late 15th century with the origins of the capitalist system rather than with the 19th century expansion in fossil fuel use.31

However, as the following section of the chapter shows, not all critical theorists have been as sceptical of the implications of the Anthropocene as Malm. Using the example of Jamie Lorimer’s work on wildlife, this section shows that some have found the concept of the Anthropocene useful in developing critical approaches to socio-natural relations. Lorimer’s work is chosen here as it is representative of a broader trend in new/vital materialisms which have become popular in geography and cognate disciplines. Lorimer has also written on human-created or novel ecosystems which have also interested dialectical biologists (see chapter six) although, as will be explained in this chapter, Lorimer is critical about the utility of a dialectical approach.

3.2.2: Lorimer’s multinatural approach
Counterintuitively, instead of adopting the hubristic view of humans as capable of manipulating the biosphere at will, several commentators in geography have taken the opposite view of the Anthropocene. The new epoch has been seen as an opportunity to reflect on the complex interconnections between humans and other species and to develop “multinatural” approaches that do not rely on notions of an external nature and treat humans as anything but

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31 Some have suggested that if environmental problems can be located with capitalism rather than with humanity, “Capitalocene” might be a better word to use (for example, Moore, 2017a). However, one disadvantage is that it is less likely to be accepted by geologists and other physical scientists (it doesn’t fit with the conventions of geological terminology). As the word “Anthropocene” has already entered common usage it may simply be too late to start proposing alternative terms.
centre stage. Therefore, the Anthropocene makes a contribution to a body of work within the social sciences that has always questioned the concept of “nature”. Lorimer describes the designation of the new epoch as “the public death of the modern understanding of Nature removed from society” (Lorimer, 2012, p1). His (2015) book *Wildlife in the Anthropocene*, which discusses the wildlife that lives in human-created environments such as cities, criticises the spatial association of nature with “wilderness” (see also Whatmore and Thorne, 1998), and provides an important example of this type of non-dualist Anthropocene thinking.

For Lorimer, the Anthropocene is interesting precisely because it offers a challenge to the assumption that “nature” can be rationally ordered, understood and managed. His work offers an alternative view of a world where human influence is entangled with the actions of non-humans, outcomes are unpredictable and socio-natural processes are “non-linear, rather than being in balance” (Lorimer, 2015, p2). Lorimer admits that his reading of the Anthropocene goes against the grain of most interpretations. Mainstream narratives tend either to emphasise human domination or control over nature or to assert that humans have too much influence and ought collectively to scale back their impact. As Lorimer points out, both of these viewpoints share the same flaw in that both rely on a binary view of nature and society. However, Lorimer argues that it is not necessary to adopt a dualist view; the concept of the Anthropocene is still young and can instead be harnessed in order to dispense with this binary thinking. Although Lorimer is critical of the ideal of wilderness, he maintains that there is nevertheless a need to account for wildlife—including the plants, animals and other living things that reside in cities and the microbiota found inside the human body (Lorimer, 2015, pp7-8; Lorimer, 2017). Such an approach integrates an understanding of processes at the global scale with those at much smaller (even microscopic) spatial scales.

Lorimer’s research compares traditional wildlife conservation with newer trends such as rewilding. The former involves an attempt to manage populations of wildlife and to conserve ecosystems in a steady state. Conversely, for advocates of rewilding, uncontrolled processes are the ideal. Rewilding is defined by one UK charity as: “the large-scale restoration of ecosystems where nature can take care of itself… It is not geared to reach any human-defined optimal point or end state. It goes where nature takes it” (Rewilding Britain, 2018). Lorimer uses the experiment at the Oostvaardersplassen in the Netherlands as an example of this trend. Started in the late 1980s, this project involved attempting to re-establish grazing processes thought to have been present in the Pleistocene era by introducing Heck cattle and konik ponies (similar to two extinct breeds) to a piece of land in the Amsterdam suburbs that had been reclaimed from the sea. Although the site was initially created by human activity and humans still actively manage it, it cannot be said to be fully under human control. Animal-driven processes such as grazing and predation are also at work and the actions of animals
have produced some unforeseen and unpredictable results such as a sudden and unexpected collapse in the population of wild spoonbills (Lorimer, 2015; Lorimer and Driessen, 2014). For thinkers like Lorimer, the Anthropocene invokes a world where human and non-human agency are inextricably bound and where ecosystems are constantly being constructed and reconstructed.

Lorimer’s work has interesting implications for how social scientists might engage with knowledges from the natural sciences. He states that “science…is political” (Lorimer, 2015, p2) and shows how the interests of conversation ecologists have shifted over time. To give one of his examples, there is now much greater interest in, and acknowledgement of, the biodiversity in urban areas than there perhaps has been in the past (Lorimer, 2015, chapter 8). But, more centrally, Lorimer’s ontological argument and emphasis on human intervention in biospheric processes means he acknowledges the role of human action in shaping the non-human world. He consequently doesn’t assume that scientists are observers from the outside of processes within nature. In other words, he takes a very different approach to science and scientists than the stereotype of the disinterested scientist discussed in the previous chapter in relation to Lukács’ interpretations.

As demonstrated in the previous chapter, critiques of dualism have also been discussed in various ways by Marxist ecological thinkers. However, in geography and other related disciplines, variants of new/vital materialism, actor-network theory and posthuman thinking have emerged as the dominant paradigm within which to discuss non-dualist approaches to the socio-natural world. Lorimer describes his own work as “vital materialist”. Rather than Marx, Engels or Gramsci, he lists Latour, Haraway, Deleuze, Bennett and Whatmore as his influences (Lorimer, 2012, pp595-597; 2015, p21). Accounts of non-human nature within human geography increasingly deal with questions of agency, they seek to engage with what non-humans can do rather than assuming that the non-human environment is something that humans act on. This “materialist turn” (Kirsch, 2013) will be addressed in the remainder of this chapter. After outlining the main tenets of new materialist thought, this section will address its influence in thinking about environmental issues and some of the disagreements between its supporters and ecological Marxists.

3.3: New materialisms

In Vibrant Matter: A Political Ecology of Things, Jane Bennett memorably describes a “sunny Tuesday morning” when she was struck by the “affect”—an intangible feeling or sensation—experienced when encountering a collection of seemingly inert objects in a storm drain—a dead rat, a bottle cap, some pollen, a wooden stick and a discarded workman’s glove:
Glove, pollen, rat, cap, stick. As I encountered these items, they shimmied back and forth between debris and thing—between, on the one hand, stuff to ignore, except insofar as it betokened human activity (the workman’s efforts, the litterer’s toss, the rat-poisoner’s success), and, on the other hand, stuff that commanded attention in its own right, as existents in excess of their association with human meanings, habits, or projects. In the second moment, stuff exhibited its thing-power: it issued a call, even if I did not quite understand what it was saying. At the very least, it provoked affects in me… (Bennett, 2010, p4, emphasis added).

As this short vignette makes clear, Bennett hopes that social theorists will take seriously the influence that non-human things have on the humans who observe them. But, furthermore, they might even come to see something like a bottle cap as having a kind of power “in its own right”, an ability to act that exhibits itself whether or not a human being is involved. Bennett hopes that theorists will engage with the materiality of things and consider what properties might enable them to exert their influence. In marked contrast to Malm’s work, which foregrounds relations between humans, work such as Bennett’s asks whether social theorists might also acknowledge the role of non-human things. Her writing is a key contribution to what has come to be called new materialism but could equally be referred to as a vibrant (or vital) materialism.

The term “new materialism” is also sometimes conflated with non-deterministic or immanentist ontologies (Braun, 2015). It covers a range of sometimes divergent theories and has been applied to the work of followers of Hobbes, Spinoza, Deleuze, Foucault, Latour, Derrida and others. However, both Braun and Diana Coole argue that these approaches have several characteristics in common, making it possible to lump them together. Coole states that thinkers from these diverse traditions “all seem happy to fly under the new materialist flag” (Coole, 2013, p452, see also Coole and Frost, 2010). As this work seeks to unsettle the distinction between humans and non-humans, some have also referred to a “posthuman” turn (see Braidotti, 2013).

The renewed engagement with materialism in geography and other disciplines is an attempt to overcome some of the perceived inadequacies of earlier forms of thought. In particular, such approaches have been described as a reaction to the dominance of language, discourse and representation in geography and other disciplines, especially in the 1970s and 1980s. This “cultural turn”, it is argued, tended to marginalise discussions of the material (Coole and Frost, 2010; Arboleda, 2017, p366). Since the mid-2000s, alongside renewed awareness and interest in ecology and engagement with the natural sciences, the human-centric assumptions of the cultural turn have been called into question (Rosati, 2017, pp4-5). As will be explained, the
new materialisms also purport to address what are sometimes seen as omissions in Marxian socio-natural thought.

Although the term “new materialist” encompasses a diverse body of work, there are several tenets that its followers generally hold in common (Connolly, 2013). Firstly, new materialism represents a renewed engagement with “matter”. Rather than being considered inert “stuff”, matter is said to be “alive with the creative potential of endless evolutions and innovations” (Kearnes, 2006, 67). For example, Bennett (2010, pp58-60) reflects on the properties of metals, describing their crystalline structure and suggesting that metals have a capacity to transform themselves as cracks spread through their structure. These capacities are seen as integral to the nature of the materials themselves rather than imposed on them from without, for example by human action.

There are, of course, many differing strands of materialist thought including historical materialism.32 As discussed in the previous chapter on ecological Marxism, materialists assert that what exists depends on matter, as opposed to idealists who assert the primacy of ideas (Bhaskar, 1992). However, Bruno Latour (in a 2007 paper entitled “Can we get our Materialism Back Please?”) argues that what has come to be referred to as “materialism” is really a form of idealised thinking that treats the material world as a set of objects that we mistake for “things”. For Latour, new forms of description are needed to account for the things of the world. The properties of objects can be described using methods such as technical drawing. Such representations provide knowledge; Watt’s diagrams of steam engines can help us understand how the elements that make up an engine fit together. But drawings fail to account for the material properties of the parts of an engine, for example the need of the parts to maintain themselves and avoid rot and decay. Therefore, the current wave of new materialisms differs from historical materialism in that its advocates call for a much greater engagement with the properties of specific things rather than asserting that work is materialist if it is based on real relationships between humans. An account of migration from rural parts of England into the cities in the 19th century, the development of capitalist relations of production and the associated changing relationship with the natural world might interest a historical materialist. However, it would not satisfy Latour’s criteria for materialism—unless perhaps the migrants were also shown to act as part of a network where water, cotton, rats, bricks, coal, etc, are equally seen to participate.

As well as its interest in matter, new materialism can be described as an “ontology of becoming” or a process-based ontology. It turns its attention to the processes that constitute

32 Marx and Engels themselves described the materialism they advocated in their own day as “new materialism” (Graham, 1973).
things rather than focusing on those things in themselves (Coole, 2013). The socio-natural world is seen as made up of constantly shifting relations—things are always either coming into being or going out of existence: “socio-ecological systems” have a “never exhausted potential to assume other forms” (Braun, 2015, p3). Like Harvey and Ollman’s dialectics, this is a radical relational approach in that it doesn’t start by looking at things in isolation before going on to analyse the way in which they might relate. Instead, it takes as its starting point the notion that those things are themselves “composed of nothing more or less than relations” (Fraser, Kember and Lury, 2005).

Furthermore, when things are not things but processes, they also become more lively, exhibiting properties including creativity and a capacity to surprise (Fraser, Kember and Lury, 2005; Connolly, 2013). Ideas that non-human nature is “chaotic”, “eventful”, “vital”, “feral”, “instable” and “volatile” have rapidly gained in influence (Braun, 2009). This way of thinking acknowledges that aspects of the non-human world have properties that are unpredictable and that defy full human explanation. Lorimer similarly reflects on the idea of “charismatic” non-human species and shows how affect might sway wildlife conservation priorities by influencing the attitudes of conservation scientists and members of the public towards different kinds of animal species (Lorimer, 2007). This renewed philosophical engagement with non-humans as lively is sometimes taken to mean that they exert a kind of “power”, as demonstrated by Bennett’s references to “thing power” (Bennett, 2010).

Thirdly, the diverse approaches referred to here as new materialist have expanded the scope of what counts as “agency”, which, as Coole (2013) points out, has been a particularly vexed issue within various social scientific disciplines. Rather than agency being reserved for humans alone, things now exhibit “agency”, or at least a capacity to make things happen. In the words of Braun and Whatmore, this thinking is about showing an interest in “the performances of things and not just the actions of humans” (Braun and Whatmore, 2010, p.xx). Such work is a decisive shift away from anthropocentrism: which sees humans as uniquely able to exhibit agency or makes rational human action the yardstick against which an entity’s capacity to act is measured. For example, William Connolly (2013) opposes seeing human subjectivity as the “fundamental ground of things” (see also Braidotti, 2013, pp13-14) and for Karen Barad “agency is not aligned with human intentionality or subjectivity” (Barad, quoted in Malm, 2018, p88). This project of displacing humans as the sole possessors of agency is often referred to as a flat ontology. For many of the thinkers who have engaged with these ideas, agency is not a property or attribute possessed by a particular human or non-human. Rather, it is better thought of as emerging as a result of the relationship between non-humans. In Hinchliffe’s work on urban wildlife, the capacity of water voles to live alongside other species such as the brown rat is not a fixed attribute of the water vole but varies depending on location. Urban
voles and rats become able to adapt their behaviour to live alongside one another (Hinchliffe, 2008).

Finally, and related to the other points concerning materiality, becoming, liveliness and agency, new materialist ontologies preclude seeing the world as fundamentally divisible into “social” and “natural” realms. Objecting to the “common sense division of the world into lively humans and brute matter” (Braun, 2011, p390), these ways of thinking pose a radical challenge to approaches that start from nature and society as two opposing poles. Here, the new materialists again take their cue from Latour, who identified the treatment of nature and society as two distinct realms as a peculiarly modern way of understanding the world (Latour, 1993). Instead, for Latour, the world is constituted by multiple hybrid things, none of which can be split apart into societal and natural elements:

Latour…would abandon the concept of nature, suggesting instead a world of socio-natural quasi-objects. There is neither nature nor society outside the cultural and discursive practices that produced this binary. Rather, the imbroglios of human and non-human things that proliferate in and constitute the world consist of continuously multiplying nature-culture hybrids that stand between nature and culture: for example, greenhouse gases, Dolly the cloned sheep, dams or electromagnetic waves (Swyngedouw, 2015, p134).

Latour’s work has been cited by various thinkers in geography. Notably, Whatmore develops a geography populated by hybrids, which in Latour’s terms cannot be conceived “as a mixture of two pure forms” (quoted in Whatmore, 2002, p2). And Noel Castree also refers to Latour’s modern constitution in an overview of ecological Marxism (Castree, 2000).

As explained above, new materialists demolish the nature/society binary by allowing for non-human entities to be considered as agents and therefore endowed with some of the capacities conventionally reserved for humans. They have also drawn attention to the inhuman forces that constitute humans themselves. The fact that all humans have a microbiome, a community of microorganisms living on and inside us, is often used to demonstrate how entangled human lives are with those of non-human species (see Gilbert, Sapp and Tauber, 2012). Therefore, one result of increased interest in the microbiome on the part of social scientists is to challenge individualistic assumptions about the human. If much of the cells making up the body of a human do not actually contain human DNA but that of multiple other species, can we so easily treat the human body as distinct from non-human nature? Can we argue that humans act on nature when human action is itself a multi-species achievement? (see, for example, Connolly 2013; Lorimer, 2017).
Although new materialism has become popular within the last decade or so, it is influenced by earlier strands of thought, especially actor-network theory, and by neo-vitalist thought. The new materialism has in turn become influential within animal geography and in environmental geography more generally. Therefore, the following briefly addresses the roots and influence of new materialist ideas before assessing the criticisms of these ideas and the debates between their advocates and ecological Marxists.

3.3.1: Actor-network theory
Lorimer (2007) says that his own vital materialist thinking is influenced by actor-network theory (ANT). Perhaps most closely associated with Latour (2005), ANT is premised on the idea that actions are the result of the coming together in networks of diverse entities, which might be human or non-human. Malm also refers to the influence of Latour on new materialism with its emphasis on the capacity of non-humans to act (see Malm, 2018, pp78-118).

As with the new materialist approaches discussed above, ANT is profoundly relational, agency arises as a consequence of the way elements of a network relate to each other rather than being an inherent property of something existing prior to its incorporation into such a network (Castree, 2002). Despite the use of the word “theory”, advocates of ANT have been reluctant to refer to it as a theory in the sense of trying to impose an explanatory framework on the world (Castree, 2005, p231). Instead they prefer a more modest approach whereby actors are allowed to build their own networks which are then described rather than explained. This sensibility is shared by Bennett who also refuses to treat things as separate bodies that can be analysed in isolation (2010, chapter 2).

ANT is also opposed to nature-society dualism. For Latour, “nature” as a way of organising non-humans should be dispensed with in favour of a recognition of hybridity. But his work is also an attempt to redefine “the social”. In his introduction to ANT, Reassembling the Social (Latour, 2005), Latour critiques the treatment of “the social” as a thing with its own properties that causes things to happen, an assumption made by social scientists when they refer to social constructionism or to the search for “social explanations” of phenomena. In contrast Latour sees the social as what is constructed by heterogeneous actors rather than the thing that does the constructing.

For Murdoch (1997), ANT is useful for geography as it focuses on interconnectedness rather than on oppositions such as that between society and nature, micro- and macro-scale or local and global. According to Murdoch, approaches that focus only on local interactions between humans fail to explain how humans can act on others more distant in time and space. To
account for this, an approach such as ANT is useful in that it shows how human action results from networks that also include non-human resources and technologies thereby amplifying the actions of humans across space.

3.3.2: Neo-vitalism

As well as being influenced by ANT, Braun (2009), detects a kind of neo-vitalism evident in the work of “new materialist” authors such as Latour and Whatmore. Traditional forms of vitalism, associated with thinkers from the 18th and 19th century including Newton, proposed the existence of a spark of life or vital force (“élan vital”) in living things that animates what would otherwise be inert (Greco, 2005; Henderson, 2012). In the life sciences, vitalists propose that life is uniquely endowed with this force, bestowing properties on living things that cannot be comprehensively explained in terms of physics or chemistry (Greco, 2005). By contrast, mechanist philosophical viewpoints assert that life—however enigmatic and unpredictable it seems—is in principle explainable using the models of chemistry and ultimately those of physics. Paradoxically, accounts that seem to be based on mathematical laws, such as Newton’s explanation of the movement of planetary bodies or comparisons of the human body to a machine, can have vitalist implications. A theory that reduces everything to knowable laws leaves no room for explanation as to how movement arises in the first place—this can only then be understood by recourse to statements about “sparks of life”. Vitalism has fallen out of favour within biology. However, it is evidently still a concern of social scientists. Various authors, including Canguilhem and Foucault, despite recognising the problems with using the term, have seen vitalism as still useful as a concept. For example, Canguilhem uses it as a polemic position or means by which to reject mechanist ideas even if it does not necessarily have any positive meaning (Greco, 2005).

Importantly, where traditional vitalism has proposed that matter is essentially inert and living things are sparked by some (mysterious) outside force, the neo-vitalism of the new materialists supposes no such external influence. For Bennett and for Elizabeth Grosz in Becoming Undone, liveliness is seen as emerging and developing from matter itself; “life is not suffused of a special substance, soul, mind, or consciousness that separates it from materiality. It is the vital indeterminacy of the material world that enables life and that life exploits for its own self-elaboration” (Grosz, 2011, p34). This power is not bestowed on objects from the outside, either by humans or by an animating force (evidently, for Bennett thing power doesn’t leave a rat when it dies). Instead it emerges as a consequence of the material properties of things and the way a collection of things is arranged (Connolly, 2013, p400).
3.3.3: Animal geographies

Alongside the growth of new materialist thinking, human geography has undergone something of a revival in its engagement with animals in recent decades. Animal geography seeks to explore the relationships between humans and other animals, the role of animals in constituting the societies in which humans live and the ways in which animals come to be associated with particular places. Geography’s engagement with animals can be traced back at least to the early 20th century. Zoögeography, a branch of physical geography, sought to measure and explain the global distribution patterns of wild animals. However, a “new” animal geography has emerged since the mid-1990s, especially among human and cultural geographers, with several calls to “bring the animals back in” (see Emel, Wilbert and Wolch, 2002). One theoretical contribution of this animal turn has been to draw attention to the constituent parts of “nature”—the attributes of particular species and even the lives of individual organisms (Bear, 2011). Indeed, research on specific animals has been key to adding texture to environmental geography, opening the black box represented by the abstract term “nature” (Wolch and Emel, 1998).

Although animal geography is not synonymous with new materialism, the two strands of thought have undoubtedly informed each other. Many animal geographers have become concerned with issues of agency, particularly with understanding the active role animals might play in producing space (Wolch and Emel, 1998; Wolch, 2002; Emel, Wilbert, and Wolch, 2002). Animal geographers, like the new materialists, have called into question whether the type of conscious intentionality associated with humans is necessary for something to be an agent (Emel, Wilbert and Wolch, 2002).

Philo and Wilbert cite Latour as a key influence on animal geographies (Philo and Wilbert, 2000, p5). For these authors, the new animal geography is related to the turn away from discourse alluded to earlier. Rather than concentrating solely on the ways in which animals are represented by humans, therefore giving the impression “that animals are merely passive surfaces onto which human groups inscribe imaginings and orderings of all kinds” they have drawn attention to the ways in which animals themselves are capable of transgressing the spatial orderings to which people have attempted to assign them. To do this Philo and Wilbert offer several examples of animals in captivity that have either literally escaped from zoos or have evaded zookeepers’ attempts to discipline them (Philo and Wilbert, 2000, pp14-23). And, for the co-authors of another recent edited collection, to be an animal geographer necessitates acknowledging non-human agency and rejecting human exceptionalism:

This growth in interest in animals partly reflects growing public concerns over animal welfare, biodiversity conservation, the environmental impacts of meat production and the ethical implications of biotechnology as well as the prominence of environmental geography as a sub-discipline of geography.
We are both firmly animal geographers. For us this means taking seriously the agency of the more-than-human world and acknowledging the capacity of all the earth’s inhabitants to affect and be affected. As such, we reject the idea of human exceptionalism and, along with other scholars who embrace the posthuman turn, seek to unsettle the presumed boundaries between the organisms that make up this world. Indeed, humans and other animals are always co-constituted—our ontologies are relational, even if the effects of co-constitution are always asymmetrical (Wilcox and Rutherford, 2018, p1).

Animals have often been both conceptually and materially assigned to particular places. For Philo and Wilbert (2000) animals can be “placed”, both in terms of being assigned to a place in a classification system such as the system of naming and classifying different organisms developed by Carl Linnaeus in the 18th century (Anderson, 2014), and by being more literally associated with particular physical places such as the wilderness or the outdoors. This obscures not only the physical presence of animals in urban environments (Wolch, 2002), but also the role animals play in human societies, for example as a source of food and clothing or in providing companionship, entertainment and inspiration. Animals are often seen as part of “nature”. Therefore, studies of the ways in which humans have come to be understood as distinct from other animals and the cultural and scientific practices that maintain this distinction offer a way of understanding how the nature-culture divide has itself been established. However, some animals such as pets can be viewed as “part of the family” and imbued with human-like characteristics, therefore demonstrating the difficulties with which such dividing lines between society and nature are drawn.

Animal geographers have also investigated the role played by human-animal relations in establishing and differentiating human identities. Elder, Wolch and Emel (1998) show how the practice of animal sacrifice in the Santería religion is seen as violating dominant ideas around human-animal relationships (in US cities where animal killing is otherwise hidden from view in the slaughterhouse). Differing ideas about how to relate to animals therefore contributed to the racialisation of a migrant group. Critical animal geography has argued that human-animal relationships cannot be understood without taking into account social relations between humans and has incorporated ideas from political economy to look at how animals have become commodities (Srinivasan, 2016; Collard and Dempsey, 2013).

As well as animals, plants are also described now as exhibiting a “lively presence”, becoming “fundamental players in human lives” as organisms we relate to in gardens and as the providers of our food and oxygen (Head and Atchison, 2009). And microorganisms are also a
focus of research, for example in Labban’s study of the role they play alongside humans in extracting metals from mineral ores (Labban, 2014).

3.3.4: New materialisms and environmental problems
As well as being influential in studies of animals, new materialism, with its emphasis on non-human agency and its challenge to dualism, clearly has implications for ecological thought more generally. For example, Bennett asks what effect it would have on politics if things that had previously been seen as inert objects came to be viewed as possessing qualities—like liveliness—usually only reserved for living creatures. She suggests that waste in a rubbish dump might be treated differently if it came to be seen not as something that can simply be disregarded but as vital matter that continues to possess a liveliness of its own. In this case the rubbish emits liquid pollution and methane into the atmosphere, continuing to “do stuff” even after humans have forgotten about it (Bennett, 2010, p6).

New/vibrant materialisms have therefore become influential in environmental geography. Divya Tolia-Kelly (2011) argues that we should take inspiration from Bennett’s (2010) book *Vibrant Matter* and “embrace the call of matter”. Karen Bakker has tried to bring together literature on neoliberalisation with that on materialism and non-human nature, arguing that failing to address the constitutive role that non-humans play in economic and societal formations has led to a “failure to address the full scope of environmental processes and socio-natural entities subsumed within processes of neoliberalisation” (Bakker, 2010, p717). These ideas have influenced geographers concerned with wildlife conservation (Lorimer, 2007; Hinchliffe, 2008), genetically modified foods (Bingham, 2006) and the role of liveliness in understandings of the commodification of living things (the subject of a set of paper presentations and a panel discussion at the AAG annual meeting 2014). Kirsch (2013), commenting on the material turn, sees materialism as connective wiring linking together various disparate approaches within geography. Although materialism is understood in different ways, approaches that emphasise the specific properties of things have become commonplace.

Perhaps one reason new materialist ideas are so compelling is that they present a challenge to the assumptions of existing political theory. Politics, it is argued, tends to focus on humans and their relationships with each other while relegating those things awkwardly referred to as “non-humans” to the background (Braun, 2011). Such a position would imply that humans see the non-human world as merely the page on which political history is written or, more problematically, as a pool of resources for human use or as barriers to human activity. It would treat non-human nature as “a mute and stable background to the real business of politics” as
Steve Hinchliffe puts it (2008, p88), or as raw material that “just exists” prior to being appropriated (Haraway, 1989, p13). This is not the same as seeing non-humans purely as recalcitrant—resisting the efforts of humans. After all, human societies would not exist without the non-human actants that have enabled them to come into being. But it does remind us that non-humans are not merely the objects of human will (Braun, 2009). As well as avoiding the dualist position that humans simply act on a passive nature, new materialism also seeks to avoid the equally problematic assumption that non-humans act due to some autonomous “natural” laws that humans are not subject to. It has even been argued that the common sense notion of agency as a capacity of intentional, thinking subjects stems from the assumption, characteristic of economic liberalism, that humans act in a rational and self-serving manner (Braun, 2008).

In summary, new materialism involves engagement with the material properties of things and some creative attempts to account for these properties in written work such as Bennett’s, an emphasis on process over fixity, a rejection of dualism and a rethink of agency that extends the concept beyond intentional human action. It has become popular in geography and, particularly in environmental geography, where it has provided an antidote to approaches that treat the non-human world as brute matter to be worked on by humans. Somewhat counterintuitively, a Latourian inspired vital materialist approach is evident in Lorimer’s work on the Anthropocene despite the common association of the epoch with overwhelming human agency.

It should also be clear from the above that new or vital materialism shares a lot in common with the ecological Marxism discussed in the previous chapter. Like the new materialists, Marxists have attempted to theorise ecological relations while avoiding dualist assumptions. The approach to dialectics outlined by Harvey and Ollman can, like the new materialism, be described as an ontology of becoming that starts with relations rather than things (Sheppard, 2008; Braun, 2006). However, there continue to be disagreements between advocates of dialectics and new materialists to which this chapter now turns.

3.4: False antitheses?
Both dialectics and new or vital materialisms are part of what has been described as a more general “radical shift to a relational ontology, a world of relations and processes and not things-in-themselves” (Kirsch and Mitchell, 2004, p689). Similarly, in the book Nature, Castree refers to both Harvey’s “new dialectics” and to actor-network theory in the same chapter on “post-natural” geographies (Castree, 2005, chapter 5). Braun (2006, p193) also points out that Harvey’s approach has drawn him into “strange proximity” with other, non-
dialectical, materialisms where both are defined here by their rejection of the notion of an external nature. But, as Castree points out, dialectics “has thus far proved less influential than...actor-network theory” (Castree, 2005, p234).

But, despite their shared ontological preferences, new materialists often differentiate their work from dialectics, with many thinkers associated with the trend setting our explicitly to develop a “non-Marxist” materialism. Bennett states, for example:

I pursue a materialism in the tradition of Democritus-Epicurus-Spinoza-Diderot-Deleuze more than Hegel-Marx-Adorno. It is important to follow the trail of human power to expose social hegemonies (as historical materialists do). But my contention is that there is also public value in following the scent of a nonhuman, thingly power, the material agency of natural bodies and technological artefacts (Bennett, 2010, p.xiii).

As this quote demonstrates, Bennett does recognise the “importance” of human power relations. But she objects to Marxism’s apparent anthropocentrism: “Dogged resistance to anthropocentrism is perhaps the main difference between the vital materialism I pursue and this kind of historical materialism” (p.xvi).

For some of its critics, dialectical thinking is, despite its claims to the contrary, unhelpfully predicated on the prior establishment of two distinct and opposing entities—nature and society—that come to relate to each other. It therefore fails to deal adequately with socio-natural concerns. Whatmore states (or at least, once stated) that: “far from challenging [the] a priori categorisation of the things of the world, dialectics can be seen to raise its binary logic to the level of a contradiction and engine of history” (Whatmore, 1999, p25). Similarly, Braun has suggested that dialectics is “too crude...to overcome dualism” and that it retains the terms of the nature-society binary “even as it seeks to place them in relation” (Braun, 2006, p199). It is hardly surprising that some can assume this given the prevalence of definition of dialectics as “the perpetual resolution of binary opposites” (Gregory, 2009, p157). Such an approach would indeed approach nature and society as if they are two separate realms and would also be crudely deterministic. However, Whatmore and Braun misrepresent dialectics here. As argued in the previous chapter of this thesis, the thinking that Whatmore criticises is precisely the kind of philosophy of external relations that Ollman and Harvey also make such a compelling case against with their contention that the things of the world are constituted by processes. As discussed in the previous chapter with reference to Brecht, dialecticians would also take issue

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34 Castree argues that “this reflects the current unpopularity of Marxism within human geography” (2005, p234) although this seems to be an overstatement given, for example, the Marxist influence on political ecology referred to in chapter one and the success of Marxist thinkers in geography more generally, most obviously David Harvey.
with the emphasis on resolution of opposites. Therefore, Castree can easily dismiss Whatmore’s criticism: “strangely this plenary claim is not based on any in-depth analysis of Marxian theorisations of the nature-society interface” (Castree, 2002, p115).

For Castree (2002), therefore, “false antitheses” have framed the encounter between environmental Marxism and approaches such as actor-network theory that call for a recognition of multiple forms of agency. While maintaining that ecological Marxism has made an important contribution to critiquing specifically capitalist environmental relations, he argues that there is a weak form of ANT that could be combined with ecological Marxism. Such a synthesis would complicate environmental politics by acknowledging the role of multiple actors (Castree, 2002, p111).

Following Castree (2002), more recent work on lively commodities has tried to bridge the divide between emerging work on non-human agency and materiality and Marxian concepts of labour, value and commodification. For example, Boyd, Prudham and Schurman (2001) have utilised Marx’s distinction between formal and real subsumption of labour, arguing that this distinction applies to the ways in which natural processes are incorporated into industrial production as well as to human labour. Maan Barua (2016) demonstrates how, in encounters between humans and large animals, for example between tourists and elephants, the physical features of the animals contribute towards what, following Donna Haraway (2008), he calls “encounter value”. The intention here is to move beyond the notion, common in political economy, that non-humans are a mere resource or a substrate on which human labour occurs towards seeing animals themselves as active participants in a process of capital accumulation. However, this work departs somewhat from the classical Marxist interpretation of value theory outlined in chapter two which relies on distinguishing a form of value that can only originate with human labour.

Despite Castree’s intervention, there is still a “muted standoff” (as Loftus, 2012, p4, puts it) between followers of Marxist and of new materialist approaches. Lorimer has raised slightly different criticisms of dialectics to Whatmore. He critiques dialectical approaches for apparently foregrounding human agency at the expense of recognising the role of non-humans, and for giving insufficient attention to the materiality of non-human nature as well as that of the human body (Lorimer, 2013). Lorimer, for whom dialectics lies “at the heart of Marxist geography” (2013, p127), contends that a version of vital materialism is much more able to account for a diverse range of actors, for example in his own research into the way non-human charisma shapes the priorities of wildlife conservation (Lorimer, 2007; 2015). Smith’s (2008) production of nature thesis attracts particular criticism here. With its explicit focus on the role of human labour in producing natures and its unapologetic anthropomorphism, it is seen as tending to “minimise the influence of nature as a material force” (Boyd, Prudham and
Chapter 3: The Anthropocene and the new materialisms

Schurman, 2001, p557; see also Loftus, 2012, pp13-16; Lorimer 2013). Lorimer interestingly suggests that Marxist thinkers have downplayed discussions of non-human agency due to a “residual Marxist antipathy…to discussions of the environment as a limit” (2013, p127). However, it could be argued in response that the production of nature is a description of how the “natural” world is treated under capitalism—not a normative statement of how Smith or his supporters might want the human relation with nature to be, but a recognition of the way nature is subsumed today. Conversely, there are criticisms of the new/vital materialisms that can be raised when considering their work in the light of the discussion of ecological Marxism in the previous chapter.

3.4.1: Criticisms of the new materialisms

While Malm’s Marxist approach usefully politicises climate change and highlights (differentiated) human responsibility, Bennett’s new materialism does seem limited when it comes to addressing political issues. Bennett gives the example of a black-out that struck the US electrical grid in 2003 and considers the grid as a network of diverse actants. Participants as diverse as wire, wood, heat, lifestyles, economic theory and “dreams of mastery” are presented in an (inexhaustive) list of things that must cooperate with each other to ensure the continuation of the power supply (Bennett, 2010, p25). One immediate concern raised by this example is that—if all of these are seen as exhibiting vitality and agency—it implies that, when the electrical grid fails, there is no single or ultimate cause of the problem. Bennett herself acknowledges that her approach makes it difficult to find someone to blame. How would one hold the electricity company accountable, for example, if the wires that make up the network are implicated just as much as the people involved? More generally the approach developed seems to prohibit the idea that elements in a network could gain power over others. Does the economic theory play a greater role in the power network than that played by the wood? Or at least act in a different way?

The assertion that everything has a kind of agency has also been accused of setting the bar too low in defining what counts as agency. The levelling up of non-humans to give them power and agency implies the levelling down of humans to the status of the non-human. Some, like William Connolly argue that they do not wish to “erase the human subject” with its own distinct capacities, they merely advocate greater acknowledgement of the role of multiple others in making human action possible (Connolly, 2013, p400). Nevertheless, one problem new materialist ideas might encounter when it comes to theorising lively commodities is that it

35 Where “political” is understood here in the broad sense as addressing relations of exploitation, oppression and dominance of some groups of humans over others rather than in the sense of electoral politics.
leaves little room to consider the differentiated ability of humans to act when compared to other living things or inanimate objects. Indeed, it is difficult to distinguish between anything as everything is an effect of the networks in which it exists. Kirsch and Mitchell (2004), while in agreement with much of Castree’s (2002) arguments for reconciling Marxism and ANT, argue that ANT would have us ignore problems of causality or the directedness of social relations and argue that we should take these seriously in order to give accounts of non-human agency some political efficacy (Kirsch and Mitchell, 2004, p687). Likewise, in the context of a discussion of science and technology that is largely in agreement with the aims of this thesis, Martín Arboleda describes how the movement of capital can be understood as a driving force in shaping technological change therefore playing a differentiated role to the actions of the things involved. Arboleda develops this argument without wishing to silence “the multiplicity of actors and agencies involved in the making of natures” (Arboleda, 2017, p362).

New materialist accounts often have relatively little to say about social relations between humans (whether exploitation of workers, gender relations, racism or other forms of oppression). As Lorimer acknowledges: “This emerging literature on multinauturalism has had very little to say about political economy and the relationships between the shifts it identifies and the ascendance of neoliberal capitalism” (2012, p602). This is not to argue that these issues are neglected entirely in this work. Lorimer (2015, chapter 7) does refer to the ways in which human relationships with wildlife differ along class and racialised lines. For example, he describes how rural Indians have very different attitudes to elephant conservation than urban Europeans (for the former, the animals pose a threat to their livelihoods and even their safety while the latter are more often concerned with protecting endangered elephants). However, this work focuses on the question of the relationship between humans and other species, tending to flatten power relations between humans. By contrast, ecological Marxism as outlined in the previous chapter necessarily builds on an integrated analysis of the way capitalist social relations have entailed damaging socio-natural relations. In an earlier paper Lorimer himself seemed to recognise this lacuna in his work, arguing that, as political ecology often does engage with an analysis of capitalist social relations there ought to be scope for collaboration between political ecologists and vital materialist geographers (Lorimer 2012).

Similarly, Krithika Srinivasan (2016), from a critical animal geography perspective, has highlighted the lack of a “political” animal geography.

Lorimer also suggests that an ontology that stresses the fluidity of natural processes and the vitality of non-human life might be unhelpful for resisting the commodification of nature. He points out that the inventiveness of non-human life is the very thing that capital seeks to incorporate (Lorimer, 2012, p603). Therefore, approaches to biodiversity conservation that emphasise the active role of non-humans might, although it is far from the intention of
new/vital materialists, end up furthering the kind of subsumption of nature to capitalist logics discussed in relation to Smith’s work in the previous chapter. Braun (2015) anticipates this criticism and points out that there is indeed a relationship between the increased interest in non-linear processes among critical theorists and the neoliberal drive to financialise the productivity of nature. For Braun, however, we ought to distinguish between the radical potential of these ideas and the ways in which capitalism has sought to contain them. In other words, these ideas might be useful to a neoliberal project but not necessarily be inherently capitalist themselves. Braun’s solution is to bring together new or vital materialist theories with critical studies of the neoliberalisation of nature including Castree’s eco-Marxist influenced work (Braun, 2015, p2).

In the black-out example mentioned above, Bennett (2010) describes how the different elements in a network collaborate to make things happen and describes the impression a fleeting encounter with some objects in a storm drain had on her. Therefore, new materialisms seem apt for describing how a group of things might hang together at a particular point in time. However, although Bennett does refer to “things” as coming together in networks rather than acting in isolation, her approach at times tends to—ahistorically—emphasise the properties of artefacts as they are encountered, rather than the processes that constitute and maintain them (Arboleda, 2017, p364). Therefore, it could be argued that the celebration of the power and vitality of things can end up treating them as distinct entities, calling into question the new materialism’s own claims to be profoundly relational. By contrast, ecological Marxism as outlined in the previous chapter, treats existing socio-natural formations as temporary and seeks to historicise them by addressing the processes by which our present situation came about (see Brincat and Gerber, 2015).

There are also epistemological reasons why Marxists have been critical of new materialist thought and of actor-network theory. Latour’s version of actor-network theory as expounded in Reassembling the Social (Latour, 2005) starts from a completely different perspective to Marxism. A “thoroughly empirical philosophy”, it is based on building an account of a particular situation from the ground up by engaging with or studying the way different actants come together to form networks that make things happen. As mentioned above, its advocates are often reluctant to refer to ANT as a “theory”, despite the name (see Bingham, 2009, p6). Latour is completely opposed to any kind of approach that adopts a particular framework and imposes that understanding on the situation to be studied such as by restricting in advance the number of actants that make up the social world (Latour, 2005, p250).

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36 In a paper based on the 2013 Antipode lecture at the RGS (with IBG) annual conference of that year.
Therefore, a strong interpretation of actor-network theory is indeed incompatible with Marxism. Marx distilled a series of general categories, such as value and exploitation, from a study of the commodity. Because his dialectics is about processes rather than things, he was able to go beyond surface appearances in order to get at “underlying” social relations (see Tyner and Inwood, 2014, p774). But these abstractions can supposedly then be applied to concrete situations in order to make sense of the world. Marxists therefore approach their chosen subject of study equipped with at least some assumptions about the workings of capitalism, referred to by Marx as the “essence of things”, rather than approaching a situation with no preconceptions and building up an understanding by observing the formation of networks. Essentially, most Marxists are not as suspicious of “theory” as actor-network thinkers.

Expanding on this point, Kirsch and Mitchell point out that, for actor-network theorists, the overriding role of competition between capitals in shaping what happens in the workplace is downplayed in favour of an approach whereby social relations are seen as the outcome of relationships between people, machines and other things (Kirsch and Mitchell, 2004, pp700-701). This lack of attention to the relations of competition and exploitation that structure the capitalist system leaves ANT oddly “politically inert”, with some of its advocates even averse to making normative judgements (Kirsch and Mitchell, 2004, pp694-695). The political propositions put forward by Connolly, a prominent new materialist thinker, are indeed extremely limited, especially given the dangers represented by climate change and the global resurgence of authoritarian politics that he describes in the same paper. Connolly proposes modest measures such as encouraging a local church congregation or trade union to take an interest in environmental issues, buying a hybrid car or joining the slow food movement and explaining your reasons why to your friends so that alliances of people with similar convictions might develop (Connolly, 2013, p411). Most of these are uncontroversial. But Connolly here seems to wilfully avoid searching for root causes of the problems he identifies (capitalism, perhaps) that might need to be addressed to solve them.

Finally, Braun has suggested that new materialist theories may be at odds with current thinking among natural scientists, including biologists. One of the aspects uniting various adherents of the new materialism is an interest in science. However, Braun (despite his sympathies with new materialism) cautions that some have offered partial accounts of scientific thinking or even overlooked theories in the natural sciences that do not fit easily with their worldview. They also forget that the natural sciences have undergone paradigm shifts with the dominant ideas changing over time and are themselves influenced by the dominant philosophical trends (Braun, 2015, p4). Elsewhere, Braun suggests that David Harvey may have been right to refer to processes as crystallising into forms at particular moments, rather than “completely
dissolving things into their relations” as new materialists tend to do. The latter, “runs counter to the same biological sciences that provided such a rich source of concepts for...non-essentialist ontology”. Braun argues that for entities such as biological organisms to exhibit agency, they must possess some kind of stability rather than simply occurring as a contingent outcome of historical processes (Braun, 2006, pp209-210). This critique is, as will be explained in subsequent chapters, remarkably similar to the work on the agency of non-human organisms developed by dialectical biologists, who agree that organisms should not be seen as merely the objects of external forces (see chapter six).

3.4.2: The return of dualism

The Marxist historian Andreas Malm, whose work on the Anthropocene has been discussed earlier in this chapter, has been vociferously critical of new materialist thinking, particularly in his most recent book, *The Progress of this Storm: Nature and Society in a Warming World* (Malm, 2018). Malm’s critique of the new materialists is related to his differences with Moore discussed in the previous chapter. The latter has sometimes referred approvingly to the recent “explosion” in relational approaches such as actor-network theory and assemblage thinking that have challenged nature-society dualisms (2017b, p289). But Moore is elsewhere also critical of such thinking, stating, in line with some of the points raised above, that approaches based on flat ontologies have been unhelpful when trying to understand power relations: “A flat ontology might be useful in very particular settings but there is nothing you can do with it when you want to understand capitalism, because capitalism is a decidedly unflat ontological formation” (interview, 3 November 2016). Nevertheless, to Moore’s own critics he is seen as flying too close to the orbit of the new materialism.

Malm attacks the new materialists specifically for their rejection of dualism and for their references to non-human agency. He maintains that there really is a difference between society and nature and makes the related point that it is humans that act on a nature composed of passive matter. While Malm recognises the importance of representations of, and ideas about, nature, these are seen as distinct from actually existing nature itself: “some sort of distinction between ‘society’ and ‘nature’ remains indispensable” (p30). Saving particular criticism for Latour, Malm remarks that a hybrid worldview, whereby it is impossible to distinguish society and nature, is central to the latter’s political thought. But, counters Malm, just because two categories become inextricably entangled, it does not follow that the categories themselves are obsolete (Malm, 2018, p51). In place of hybridism, he asserts that historical materialism is a property dualism. In other words, we ought to accept that humans and the rest of nature are of the same substance, enabling society and nature to be closely interlinked and to influence each other in multiple ways, but also maintain that humans express conscious thoughts and
intentions not seen elsewhere in nature. Attributes unique to human society are described here as emergent properties and as dependent on nature but not reducible to it (2018, pp55-58).

Malm’s response to the criticism of dialectics advanced by both Latour and Whatmore above is interesting here as he actually agrees with both when they say that dialectics is built on binary oppositions: “Yes, dialectics is the dance of opposites and requires at least a dyad” (p59). This is clearly in contrast to Castree, for whom Whatmore is ill-informed and mistaken in her assumption that dialectics relies on binary oppositions.

As well as its critique of dualism, Malm also disagrees with the new materialist interpretation of agency. For Malm, there are many situations where it is morally or politically inappropriate to assign agency to non-humans. To use his example, if there is a riot and someone intentionally throws a stone and breaks a window, or unintentionally hits and injures another human, it is not feasible to say that the stone itself plays the same role and bears the same amount of responsibility for the action as the person (even if it is accepted that the stone has some material properties that allow it to hurt someone when thrown with force—Malm, 2018, pp93-94). Of course, this is a valid, if somewhat obvious, point. And, as mentioned above with regard to Bennett’s example of the black-out, new materialism does indeed raise issues when it comes to finding someone to blame for a particular event. Few would argue that stones should be tried in a court of law for their role in breaking windows! However, this tends to miss the point. The new materialists are trying to avoid conflating agency with rational human action which some see as a liberal assumption. The legal system must necessarily treat people as individuals and as rational decision-makers when assessing who is responsible for committing a crime. However, it ought to be possible to acknowledge the things that non-humans can do, as in Bennett’s other example of the landfill spewing out waste into its environment, without the rubbish needing to act rationally and consciously and while also acknowledging the actions of humans in dumping the waste.

By resurrecting a distinction between society and nature, Malm pits himself against not just new/vital materialist tendencies, but much of contemporary political ecology. As explained in the previous chapter, there are Marxist approaches to theorising socio-natures such as Smith’s production of nature thesis and Loftus’ work in urban political ecology that are also founded on a rejection of dualism (Smith, 2008; Loftus, 2012). This thesis argues that there are genuine reasons to be critical of dualism and to acknowledge the role of non-humans in modifying the biosphere. Therefore, new materialism, by raising these two issues, offers a challenge that Marxists ought to take seriously, despite some of the limitations of new materialist work referred to above. Furthermore, the work of the dialectical biologists accepts this challenge by suggesting a non-dualist Marxist approach that does indeed theorise the actions of non-humans.
3.5: Conclusion

This chapter has introduced the concept of the Anthropocene, a proposed new epoch defined by human influence on Earth system processes. It has provided an overview of some of the key debates around when the Anthropocene began—and why it began at that time—and argued that these debates matter to environmental geographers as well as to geologists. For some optimistic advocates of a “good” Anthropocene, the new epoch provides an opportunity to envision a future of conscious human manipulation of planetary processes towards more beneficial outcomes for humans and other species. However, as demonstrated in the preceding chapter, this deeply problematic post-political approach evades questions of what kind of future we might be heading for and who gets to decide. In contrast, it is argued here that the Anthropocene is more interesting for what it tells us about the past than the glimpse of a high-tech utopian future offered by some of its advocates. It can be seen as an opportunity to develop an understanding of how socio-natural relations have developed through time and address the causes and consequences of what appear to be abrupt shifts in these relations at different points in human history.

The Anthropocene raises several questions relevant to the subject of this thesis. Firstly, there is the question of the type of knowledge needed to make sense of the new epoch. For some, it cannot be adequately understood without insights from the social and natural sciences; there is a need for an integrated approach to analyse changes within human societies and the way in which humans adapt their external environments. Therefore, new collaborations across the disciplinary divide generally placed between the social and natural sciences are needed (a point made in Castree, 2015). Secondly, the concept of a human-created epoch gives a new urgency to long-standing debates about the status of “nature” and particularly the extent to which nature can or should be considered as separate from human societies. Thirdly, and related to the second point, the debates about the Anthropocene rest on differing interpretations of human and non-human agency. For some, humans seem to possess an unprecedented power to control what happens to the biosphere. However, this is not the only interpretation.

This chapter has contrasted the response to the Anthropocene from Andreas Malm and Jamie Lorimer, representative of ecological Marxism and of the new/vital materialist tradition in geography. Malm is dismissive of the term Anthropocene and pursues an approach that foregrounds conscious human agency and particularly class struggle. However, Lorimer, although recognising the problems with some accounts of the Anthropocene, nevertheless finds the term useful, particularly as it signals the “public death” of nature as removed from human society (see Lorimer, 2012). Lorimer has brought together a particular interpretation of the Anthropocene with vital materialist thinking. The two ideas might seem counterposed, the former seems to emphasise human agency to such an extent that it views it as a global
geological force, while the latter body of work seeks to extend agency to make it a consequence of networks of actants rather than the sole property of human agents. However, for Lorimer, the two can be brought together for those willing to adopt a multinatural approach, understanding the Anthropocene as arising from both human and non-human agency and resulting in an unpredictable world of hybrid spaces and things (Lorimer, 2015). In this way, work such as Lorimer’s offers a counter to human exceptionalism, with its associated post-political emphasis on using technology to guide the way to a more sustainable future. Conversely, Malm, by singling out what is unique about intentional human agency and referring to the rest of nature as inert matter tends to buttress these exceptionalist ideas.

In summary, although some Marxists have written on the Anthropocene, it is new/vital materialists who seem to have more fully addressed the theoretical consequences of the new epoch. The dominance of such approaches in geographical discussions of the Anthropocene may reflect the relative popularity of new materialist approaches among environmental geographers generally. However, as recounted in this chapter, there are several criticisms that can be made of new materialist thought, particularly the tendency of these theories to downplay causation and power relations and to overlook the processes through which networks of actants come into being.

Although many within the new materialist fold explicitly oppose their approaches to Marxist accounts of socio-natural systems, as explained here there are more similarities between the two ways of thinking than is sometimes assumed, particularly as both are part of a shift towards relationality. The argument made by some that dialectics relies on a binary logic has been effectively refuted. But the other criticism—that ecological Marxism plays down non-human agency and materiality—poses more of a challenge to Marxist discussions of nature. Some argue that historical materialism, as it centres on an analysis of production under capitalism, is anthropocentric, privileging relations between humans and relegating non-human actors such as animals to the background (Braun, 2009). Therefore there is an ongoing debate between followers of Marxist approaches, who politicise and historicise environmental change but sometimes have little to say about non-human agency (or are even actively opposed to accounting for it), and new/vital materialists, who are centrally concerned with non-human agency but (as they recognise themselves) underemphasise the political dimension of environmental questions.

After a brief methodological chapter, chapter five will speak to both sides of this debate by addressing the contribution of the dialectical biologists. It is argued here that, far from rejecting issues of materiality and non-human agency, these are actually major concerns within the work of this particular group of Marxist thinkers. Therefore, it is useful to engage with the
way in which biologists have developed an understanding of dialectics within their own discipline in order to demonstrate a way forward for theories of socio-natures.
Chapter 4: How to study scientists?

This thesis is a largely theoretical work. However, I have also made use of interviews with key informants in order to triangulate the information gained by reading articles these biologists have written about their thinking. As Richards (1996, p199-200) points out, information about a person’s beliefs and ideologies, their subjective analysis “can rarely be gleaned from examining books, documents or records”. Arksey and Knight (1999) add that this type of methodological triangulation can be useful as a way of ensuring that an understanding gained from another method such as by reading what the person has written is valid (confirmation) and that it can lead to insights that, in this case, could not be gained just by reading their work (completeness). Triangulation is a method of looking at the same subject from different angles. So that the interview responses can be related to written work by the same person, the participants in the study are mostly identifiable by name in the final thesis (subject to their informed consent).

Existing studies of scientists and their ideas are often based on either ethnographic or interview-based research. Ethnographies, spending extended periods of time accompanying and observing scientists, have perhaps been most useful when studying their everyday practices and how these relate to the way they “construct” scientific knowledge. Examples of this approach include Latour and Woolgar’s (1979) classic Laboratory Life and more recent work such as that of Eva Hayward (2010), who worked alongside a PhD marine biology student as a lab assistant. Hayward developed a theory of human-animal interactions similar to Donna Haraway’s work in When Species Meet (2008) and based on her own experiences of handling the animals as well as conversations with her biologist colleague.

However, reading scientific papers and carrying out interviews is still a common way to research scientists, particularly when it is their ideas that are of primary interest rather than their everyday practices. For example, the various extended interviews collected together as part of the British Library's Oral History of British Science project chronicle the life stories of well-known scientists in various fields (http://sounds.bl.uk/Oral-history/Science). Simon Reid-Henry's research on the Cuban biotechnology industry, although originally intended to be
“ethnographic” was, in reality, primarily based on studying archival material and interviewing key informants. Reid-Henry adds that attending conferences was a useful way of getting an impression of the social relations under which such research was being carried out (Reid-Henry, 2003). Lastly, Rachel Mason-Dentinger's PhD research on the history of the theory of co-evolution within biology involved oral history interviews with five named biologists who were instrumental in the development of the idea as well as archival research (Mason-Dentinger, 2009 and personal communication 20 February 2014).

Marxist biologists work on a diverse range of subjects including developmental biology, genetics, neuroscience, evolution and ecology. This suggested that an extensive approach involving speaking to several different people would be more appropriate to my own research than an intensive ethnographic study of one particular scientist or laboratory. The focus of the interview research on scientists’ approach to, and understanding of, their work means that a qualitative approach proved more appropriate than one based on quantitative methods such as a multiple-choice survey. As a part-time student, constraints on my time and budget also made it difficult to visit a field site for a single continuous period of time although it did have the advantage of giving me a comparatively long overall time period in which to identify and contact suitable interview respondents.

4.1: Finding the sample

The interview participants in chapter five are ten biologists who use the word “dialectical” to refer to their work. Many of them were associated with the group Science for the People (SftP). Four were recruited by contacting participants in the 2014 Science for the People conference (which I attended). Additionally, Richard Lewontin was a key informant in this research as one of the co-authors of the 1985 book The Dialectical Biologist. Other interview participants were contacted either by asking for volunteers on the SftP email list, because they had contributed to edited book collections on dialectical biology, or by recommendation from other interviewees. Interviews were carried out in person or by Skype or phone where it wasn’t possible to meet up and audio recorded. Early in the project I also spoke informally to Richard Levins, Steven and Hilary Rose and to Oxford based Marxist biologist John Parrington.

It became clear that Levins and Lewontin’s work is a significant influence on a particular group of scientists and that most of the interview participants had worked with one or both of them; the participants therefore represent a distinct tradition who refer to dialectical thought and are closely associated with these two influential individuals. One exception to this was an interview participant who was not sympathetic to the Levins/Lewontin project but who refers to dialectics and who another contact advised me to speak to. This confirms Peter Taylor’s
argument that there is a “visible college of Marxist scientists in the USA” as well as a more
general culture of science criticism (2010, p241) although those explicitly advocating a
Marxist approach are, of course, a minority among biologists in general.\(^{37}\)

Many of the participants in this research had been members of Science for the People (SftP), a
left-wing and anti-imperialist organisation that campaigned on various political issues related
to ideas within science and to its uses. SftP was active between 1969 and the mid-1980s.
Former members use an email forum to keep in touch and were reunited at a three-day
Schmalzer and colleagues at the University of Massachusetts, Amherst. I attended this
conference and in writing this chapter I am indebted to the organisers for hosting it and for the
resources collected at the conference website (http://science-for-the-people.org/) and in the
associated book (Schmalzer, Chard and Botelho, 2018). There are also efforts by the
University of California, Berkeley to archive and make available copies of a bimonthly
magazine produced by SftP. Although I didn’t systematically utilise the magazine archives in
this thesis they could provide material for future research.

Some biologists, while not seeing themselves as dialectical thinkers or part of the same radical
milieu, have incorporated the ideas of these thinkers into their own work. In particular,
research in niche construction biology is strongly influenced by Lewontin’s work (see chapter
six). I interviewed a further two leading figures in this area of biology in order to find out more
about their philosophical approach and influences. In addition to this, a group of six
environmental social scientists (broadly defined here as political ecologists) were recruited on
the basis that they had referred to the dialectical biologists in their work and had been
particularly prominent in debates around the influence of dialectical biology in the social
sciences. On contentious issues such as the debates between advocates of world-ecology
approaches and metabolic rift theories I made efforts to speak to representatives of both sides.

In several cases I used snowball sampling—asking each respondent to suggest other people
that it might be worth contacting—as a method of identifying further suitable respondents.
Snowball sampling is associated with hard-to-reach groups of respondents. However, it has
come to be used quite widely in social research (Biernacki and Waldorf, 1981). One advantage
of this approach is that it allows for an understanding of the dynamics of a social network, for
example in this case it could mean that participants refer to each other’s work and discuss any
similarities or differences in interpretation. A referral by someone known to a respondent can
also help to gain the new respondent’s trust. However, the snowball method has been criticised

\(^{37}\) The term “visible college” is a reference to Werskey’s classic (1988) study of left-wing British
scientists of the 1930s.
as interview participants might (whether intentionally or not) lead the researcher towards others who share their own view and therefore exclude those with differing views. This could lead to partiality if a small group who personally know each other are interviewed and others left out. I minimised this risk by ensuring that I found at least some of the respondents—starting new chains of contacts—by other means such as by searching the literature (Biernacki and Waldorf, 1981, p149). However, as the group of scientists studied here are quite a small group with a shared interest who make their own attempts to contact one another (by organising conferences and email forums) it seems almost inevitable that many of them will know one another personally or at least be aware of one another’s work.

4.2: Carrying out interviews and interpreting the results

I used semi-structured interviews with suitable probes during the interview in order to encourage the respondent to elaborate on points of particular interest and to explain further any areas requiring clarification (Arksey and Knight, 1999). It was also useful to listen to each interview after carrying it out and reflect both during and after the interview on whether the interview had adequately achieved its goal (see Keats, 2000, pp50-51).

Some of the intended study participants, both the biologists and the political ecologists, are well known and influential in their fields. Therefore, the literature on “elite” interviewing, where the power balance is tipped in favour of the interviewee rather than the interviewer, proved particularly useful (Richards, 1996; Dexter, 2006 [1970]). There is no definitive answer to the question of what makes someone an “elite” and the term is more often used to refer to political elites. However, various characteristics of the people interviewed here put them in the elite category: having been interviewed before (although by researchers with different agendas to my own); respect and recognition within their own professional circles; being well informed—including having some knowledge of the social sciences and therefore understanding of my research aims—and being themselves academics familiar with the norms of academic research. In elite interviewing the researcher must be open to the idea that the interviewee may wish to control the interview in order to put across their particular viewpoint. Therefore, in the interviews I found it useful to have a clear idea in advance of the most important questions to ask and to make sure to ask those while allowing the conversation to stray from the topic to some extent in order to build rapport. As various textbooks on social science methodology make clear, it is not possible to replicate interviews exactly with different respondents: “the contradiction between the need for ‘rapport’ and the requirement of between-interview comparability cannot be solved” (Oakley, 2003, p255). Dexter (2006) also advises that it can be counterproductive to attempt to carry out interviews from a position of “neutrality”. Therefore, I have tried to think of myself and the scientists I speak to as
participants with some common understandings, rather than adopting the position of a sceptical or critical commentator.

Richards (1996) advises that it is very important to gain a thorough knowledge of the subject area in general and the particular individual’s background before attempting to carry out an “elite” interview; advice that I took on board. A question that might make sense to an ecologist would be less immediately relevant to a developmental biologist. Therefore, the questions needed to be specific to the participants’ own individual research interests. The range of research interests also meant that I needed to gain a reasonable level of understanding of the participants’ work in order to have a meaningful discussion of their ideas. This was helped by my own background in biology but meant that it was beyond the scope of the project to interview practitioners of other areas of science such as physics or mathematics in the required detail.

The interviews allowed for an in depth understanding of the context in which the scientists developed their ideas, for example, how their approach to their subject relates to that of their peers, whether and in what ways they see Marxist or dialectical approaches as distinctive and what influenced them in taking such an approach. As some of the participants have had long careers, it was also an opportunity to discuss the extent to which they feel their work has continued to be influential. Many of the scientists spoken to here have taken a considerable interest in the philosophy of biology (for example, one respondent with whom I discussed his early work in biology would probably now consider himself a sociologist of science). Therefore, they often had lots to say about the wider social implications of their work and it was possible to speak to them in an atmosphere of mutual understanding about these ideas.

Interpreting and presenting qualitative interview data offers its own challenges that in some ways go beyond those of interpreting quantitative data using statistical methods (Arksey and Knight, 1999). In this case the interviews were transcribed, coded and arranged by theme into comments about reductionism or complexity, dynamism/change and materiality, themes that emerged from the interviews as well as regularly appearing in their written work.

This research was approved by the relevant research ethics panel (GSSHM reference: REP/13/14-13) initially for three years from the 4 February 2014 to 4 February 2017. The approval period was extended for a further year from 13 March 2017 to 13 March 2018. The research was carried out according to the British Sociological Association’s guidelines for ethical practice (www.britsoc.co.uk/about/equality/statement-of-ethical-practice.aspx) and the departmental risk assessment procedure.
Chapter 5: Making and practising a dialectical biology

This chapter asks what it means to practise dialectical biology—in other words what difference a Marxist philosophical influence can make to a biologist’s core assumptions. It is based on interviews with ten biologists carried out between 2014 and 2017, many of them members of Science for the People (SftP) as well as their written outputs and other supplementary sources such as published interviews carried out by others and video recordings of conference presentations.

But before expanding on the ideas common to the biologists interviewed, this chapter begins by situating the 1970s and 1980s generation of radical scientists in the context of debates about left-wing politics and science dating back to Marx and Engels’ own engagement with the natural sciences in the 19th century and encompassing the experiments in “proletarian” science in the Soviet Union in the 1930s (see chapter two). SftP developed an approach to the role of ideology in scientific practice distinct from that of previous generations. The chapter continues by exploring the key contributions of the dialectical biologists, with particular emphasis on the themes of reductionism/complexity, dynamism and materiality, themes that emerged during the course of the interviews as well as being prominent in their written output. As Kircz (1998) points out, Marxian social scientists and historians have tended to focus on issues such as the role of science and the context in which scientific practice takes place. Relatively little attention has been paid to what Marxism might contribute to the content of scientific knowledge. This chapter therefore interrogates what might be described as debates “internal” to science, although, as discussed below, it makes little sense to strictly separate what is internal and what is external to scientific practice.

The existence of self-identified dialectical biologists demonstrates that biology is far from unified; in fact, as will be explained, there is an ongoing and sometimes fractious debate between evolutionary biologists who propose a major rethink and those who feel that evolutionary theory is essentially fine as it is (see Laland et al., 2014). If social scientists are to make reference to ideas in biology (as many say we should) we should remain aware that biology is not a single body of thought but encompasses a plurality of views (Meloni, 2014).
By focusing on dissident and sometimes controversial scientists, which are relatively under-researched, this chapter adds to our knowledge of this diversity. Scientists are not thought of here as having privileged and unmediated access to the truth. Their understanding is structured by metaphor (and those metaphors are themselves debated) and in this case they are often openly influenced by their political ideologies.

Many of the thinkers discussed in the previous chapters of this thesis have asserted that science is “political”. Both Erik Swyngedouw (2015) and Jamie Lorimer (2015) have stated this and both have argued, in different ways, that social scientists cannot treat ideas from the natural sciences as the ground on which to build theory; scientific knowledge itself is open to examination and critique. However, the implications of a political science are not always themselves fully interrogated. As this chapter will show, for some radical scientists, although science is not seen as neutral, they are nevertheless able to hold the apparently contradictory view that science is different from other forms of enterprise in that it does find out truths about the world.

5.1: Science for the People
Described by Schmalzer and others as the “most important radical science movement in US history” (Schmalzer, Chard and Botelho, 2018), Science for the People was a movement of scientists and activists initiated in the United States in 1969 (Moore, 2013). The organisation was sympathetic to various causes on the radical left; as Katherine Yih recalls: “it was very much part of the larger social movement”, the “New Left” of the late 1960s and 1970s (Yih, 2014). Members worked with trade unions particularly around workers’ health issues, developed science teaching programmes for inner city schools, were involved in the women’s movement, opposed racism and police violence and took part in solidarity campaigns for Cuba, Vietnam and Nicaragua. In 1973 ten of its members visited China to observe what they saw as the development of a non-elitist approach to science (Greeley and Tafler, 1980, p374). SftP published a bimonthly magazine, also called Science for the People (Moore, 2013).

By 1970, SftP had established around 10 chapters (Moore, 2013) and by 1975 was able to list 29 chapters in the US alone on the back page of its magazine (Science for the People, 1975, p39). There was a related organisation in Canada and, in Britain, the British Society for Social Responsibility in Science was also established in 1969 (Rose and Rose, 1972, p123; Castree, 2017, p64). A French collective of socialist scientists and journal, Impascience, emerged from the student movements of 1968, and there were groups of radical scientists in Italy, Australia, Ireland and at the Max Planck Institute in West Germany (Rose and Rose, 1979, p320; Science for the People, 1975, p39).
In the US, SftP had a decentralised structure with its chapters operating somewhat independently of the national organisation and with decisions largely being made by consensus, although there were attempts to hold regional and national conferences (Greeley and Tafler, 1980, p377). Although the membership seems to have agreed on a broad set of principles at least in its early years, different groups were free to engage in different campaigns depending on the expertise of members and what was judged most relevant in their locality.

SftP attended major scientific conferences, often using demonstrations and political theatre, distributing leaflets and sometimes publicly confronting individual scientists they disagreed with and disrupting conference sessions. According to physicist Herb Fox, a prominent member, they “decided to make a lot of noise and disrupt things” (Fox, 2014). On one occasion blood was spilled; SftP member Frank Rosenthal was stabbed with a knitting needle by the liberal biologist Garrett Hardin’s wife Jane for refusing to stop heckling a conference speaker, an attack from which he still has a scar (Moore, 2013, p166). Some of SftP’s members attracted the attentions of the FBI and one early supporter, mathematician Chandler Davis, was called before the House Un-American Activities Committee in 1954 after his name was found on a cheque used to pay a printing company for leaflets. Davis was fired from his job at the University of Michigan and blacklisted, forcing him to move to Canada to seek work (see Woodhouse, 2011).

5.1.1: The myth of the neutrality of science

From the start, the very existence of a highly politicised group of science activists called into question the common sense assumption that the natural sciences are “neutral”. The organisation grew out of the anti-Vietnam War movement and SESPA (Scientists and Engineers for Social and Political Action) which had campaigned to try to get the American Physical Society, the professional organisation for physicists, to make statements of members’ views on political issues, in particular to take a stance against the war (Rose and Rose, 1972, p120).

A related campaign begun in 1971 by SftP against the Jason Program also brought into perspective questions of the supposed neutrality of scientists. The Jason Program, ultimately funded by the US Department of Defense, offered physicists substantial funding to carry out research of military significance while still having opportunities to pursue their academic research. Liberal Jason scientists defended their roles in the programme by arguing that they were doing “good” science, in other words providing accurate and testable information about physics; what the government did with that information was not their concern. Some argued
that it would be better for the Department of Defense to have access to accurate physical information rather than “bad” or inaccurate information.

This position reflects a general assumption that science is in itself neutral or even progressive and problems arise when that knowledge is abused—in other words that the uses of science are distinct from its content. It is also argued that the response of some of the Jason scientists reflected the individualism of scientific practice in a capitalist society, the appropriate role of the scientist became an issue of individual moral responsibility rather than scientists recognising and seeking to transform the social structures within which their work is carried out (Rose and Rose, 1972, pp106 and 128). By contrast, for the activists in SftP/SESPA, there could be no “good” science that aided the military. Not taking a position against militarism during the Vietnam War was not a neutral act but implied accepting the existence of the imperialist capitalist system in which science is practised. For Hilary Rose, the experience of confronting the militarisation of science meant that the attitude of science activists after the 1960s differed significantly from the Marxist orthodoxy of the previous generation which, as mentioned in chapter two, had tended to assume that science was neutral and had only to be utilised in a more socially just society (Rose, 2004 [1983], p69).

The radical scientists of the 1960s and 1970s have argued that the very idea of science as objective can benefit people who don’t want society to change. Science can naturalise society in its present state, giving the impression there is an underlying objectivity to the status quo, most perniciously when science adopts some of the assumptions of society and reflects them back at us while telling us they are objective facts (see Muñoz-Rubio, 1999). Therefore, SftP members were critical of the idea that scientists should abstain from political matters. Lewontin argues that the social role of science and its practice cannot be separated out: “It is time to stop saying that science stands outside of society. Science is a social activity just like being a policeman, a factory worker or a politician” (Lewontin, 1970, quoted in Moore and Hala, 2002).

As this quote from Lewontin suggests, another way to challenge the assumption of scientific neutrality is to question the perception that the social and natural sciences are inherently different. Levins and Lewontin emphasise that they see dialectics as a method applicable to both “social” and “natural” sciences because there are fewer differences between the disciplines than has been assumed. They refute the stereotype of a social scientist who is engaged in their object of study as opposed to the purely objective natural scientist (Levins and Lewontin, 1998). But, furthermore, from a non-dualist point of view, the similarities between the social and natural sciences can also come about due to the underlying similarities within the subject matter of both. For example, Levins and Lewontin criticise the assumption that the natural sciences deal with deterministic systems that are essentially reducible to mathematical
equations. Like the social sciences, biology must also account for complexity and contradiction (Levins and Lewontin, 1998).

5.1.2: Of the people or for the people?

In the late 1960s the Black Panther Party (BPP) had set up a network of free clinics to provide healthcare to those who could not otherwise afford it (as well as initiating the better-known Free Breakfast for School Children Program). Science for the People members saw this as an opportunity to try to democratise access to scientific knowledge. They set up the Technical Assistance Program (TAP) with the aim of providing support for the BPP and some acted as volunteer doctors (Zimmerman et al, 2018 [1972]). Fox helped set up an electricity generator to support one of the community medical projects—when the generator proved too noisy, he recalls going out in the middle of the night and covertly hooking wires up to the city power supply (Fox, 2014). Biologists Richard Lewontin and Richard Levins also refer to their association with and sympathy for the Panthers. As they recall in one of their books on biology: “On the day that Chicago police murdered Black Panther leader Fred Hampton, we went together to his still bloody bedroom and saw the books on his night table: he was killed because of his thoughtful, inquiring militancy. Our activism is a constant reminder of the need to relate theory to real-world problems as well as the importance of theoretical critique” (Levins and Lewontin, 2007, p10).

As SfP grew, its members often found themselves working on a range of projects including those with manual workers and trade unions, black and Latino/a Americans and people in the Global South. It would be possible to treat the scientists as a privileged layer separate from “the people”. As scientists they often possessed not only relative wealth but also substantial expertise and found themselves using that expertise to help others—in other words, doing science for the people rather than engaging the public in a science of or by “the people”. This is an issue that Greeley and Taffler (1980), reflecting on the organisation’s first ten years, were keenly aware of and that was also brought up at the 2014 conference. Several of SfP’s members were themselves from working class backgrounds and the group involved some students, teachers and industrial scientists as well as academics. However, it remained a predominantly professional (and mostly white) organisation. Greeley and Taffler also mention that women members “had to struggle to be heard” on the issue of sexism and that some left the organisation as a result (1980, p380). However, they add that progress had been made to address this and the Science for the People magazine did regularly address issues of women’s liberation including the marginalisation of women in scientific professions (see Rose, 2004 [1983] for a useful discussion of women in science and of the limitations of groups like SfP in addressing this).
Kelly Moore (2013, chapter 6), following Brian Martin, refers to four possible ways of doing citizen centred science:

1. Science for the people with research agendas set by industry or government.
2. Science for the people but where agendas are set by knowledge of wider social needs.
3. Science by the people where citizens actively participate in scientific research.
4. “Science shaped by a citizen-created world” where society is organised so that citizens determine all productive activity.

Moore says that SftP tended to practise science for the people of the second type. Although its members were responding to real societal needs, there was still something of a separation between them and “the people”. For that reason TAP, referred to above, was ultimately short-lived. It resulted in scientists doing work on behalf of community organisations rather than providing them with the expertise to help themselves, its original aim (Greeley and Tafler, 1980, p372).

The original SftP became much less active after the mid-1980s but since 2014 there have been efforts to revive it. As scientists and their supporters demonstrated against Donald Trump’s policies on 22 April 2017, several of the group’s members (from the original organisation and the revitalisation effort) took part in the protests (Mervis, 2017). And a public launch event for a new magazine and documentary film took place in New York in July 2018.

Members of the group came from a range of disciplinary backgrounds. However, this thesis is concerned in particular with biology and especially with the work of Richard Levins and Richard Lewontin. In 1985 the pair published a popular and influential collection of essays: *The Dialectical Biologist*. The book was dedicated to Engels: “who got it wrong a lot of the time but who got it right where it counted” (Levins and Lewontin, 1985). As political economist Paul Burkett notes, they are two of the most prominent scientists to say that they were doing science in an explicitly historical materialist way (Burkett, 2013). They are the thinkers who have most clearly and consistently articulated a dialectical view of biology.

Levins and Lewontin both became professors at Harvard University, working on population biology and evolutionary theory respectively, and combined their distinguished academic careers with active involvement in SftP. Between them they have a wide range of interests. Within their book one can find criticisms of some of the statistical methods used in biology, their thoughts on human nature and accounts of their work on agriculture in the Global South (especially Cuba). Lewontin in particular has been associated with a critique of the notion of biological race, pointing out that there is greater genetic diversity within supposed races in humans than there is between people from different racial backgrounds, a critique that addresses head-on the issue of the supposed neutrality of scientific knowledge as it exposes the
racial assumptions of some of Lewontin’s contemporaries (see Lewontin, 1995). Levins and Lewontin’s ideas have proved influential among biologists in the US and elsewhere with, for example, the emergence of the theory of niche construction, most closely associated with Richard Lewontin. As discussed in chapter five, various social scientists including Ted Benton, Paul Burkett, Brett Clark, John Bellamy Foster, Maria Kaika, Giorgos Kallis, David Harvey, Hannah Holleman, Jason Moore, Erik Swyngedouw, Michael Watts and Richard York have also cited their work.

Levins and Lewontin are not the only biologists associated with SftP. Stephen Jay Gould was, as well as being a notable palaeontologist and a famous populariser of science, active in SftP and involved in protests against the Vietnam War (according to Levins and Lewontin who worked closely with him, Levins and Lewontin, 2002). 38 Gould argued that “dialectical thinking should be taken more seriously by Western scholars, not discarded because [the Soviet Union] have constructed a cardboard version as an official doctrine” (quoted in Gasper, 2002) and pointed out that dialectics attempts to overcome the limitations of both reductionism and holism (see also Holleman, 2015), precisely the limitations that biology seemed to be running up against.

Other biologists who were members of, or otherwise associated with, SftP include geneticist Jon Beckwith, Anne Fausto-Sterling, who specialises in gender and gender identity, Jonathan King, who researches the biology of protein structure, ecologists Doug Boucher and Margaret Reeves, epidemiologist Katherine Yih, neuroscientist Martha Herbert, Ivette Perfecto and John Vandermeer, both agro-ecologists, and biological anthropologist Alan Goodman. David Schwartzman, these days more likely to be found advocating a rapid global transition to solar power, was also an SftP member and professor emeritus in biology at Howard University (Schwartzman, 2015). In Britain the neuroscientist Steven Rose is one of the best-known advocates of a Marxian method in biology. With Hilary Rose, he has also co-written several articles on the politics and sociology of science. The “dialectics of biology” conference in Bressanone, Italy in 1982 brought together biologists interested in these ideas and resulted in the publication of two volumes of articles: Against Biological Determinism (Rose, 1982a) and Towards a Liberatory Biology (Rose, 1982b) both edited by Steven Rose.

38 As well as writing critiques of scientific racism, Gould was an anti-racist activist. As an undergraduate student in the 1960s he organised protests against a Bradford dance hall that operated a colour bar (Gasper, 2002).
5.1.3: Breaking with Lysenko

Science for the People are often mentioned in the same breath as earlier radical science movements including the generation of left-wing scientists of the 1930s described in chapter two. For example, Noel Castree includes a brief section on political scientists of the past to assess the prospects for a more politicised geoscience today (Castree, 2017, p64). Castree refers to the visible college of the 1930s and to scientists in both Britain and the US in the late 1960s and 1970s (the experience of the Russian Revolution is not mentioned). However, American scientists in the 1970s were operating in a very different context from that of their predecessors. The following section therefore discusses the important but subtle and somewhat overlooked differences between the generations.

At first glance, there are indeed some similarities between the ideas of the 1970s generation and those of earlier Marxist thinkers. The resemblance between Levins and Lewontin’s ideas on the relationship between organism and environment and the earlier insights of Christopher Caudwell mentioned in chapter two is one example of a striking similarity between the thinking of the 1930s and 1970s generations. Figures from the 1930s like Haldane and Bernal undoubtedly influenced SfP’s thinking (Levins and Lewontin, 2002; Schmalzer, Chard and Botelho, 2018, pp13-15).39

However, as Schmalzer and others point out (2018, pp14-15), by the late 20th century, the use of nuclear weapons in war had eroded the assumption on the left that science was a force for good that had merely to be harnessed towards creating a better society and the Soviet Union was no longer a key point of reference. As part of the post-war New Left, biologists interviewed for this thesis were more likely to cite contemporary political struggles such as opposition to the Vietnam War, solidarity with Nicaragua or civil rights in the US as formative influences than the ideas of the 1930s left. Perhaps more fundamentally, scientists involved in SfP were less interested in dispensing with bourgeois science and developing an all-encompassing “proletarian science” in its place than those of earlier generations. We can address the differences between Levins and Lewontin’s generation and that of their predecessors by looking at how these authors themselves responded to the proletarian science debate. Fortunately for this purpose Levins and Lewontin included their thoughts on Lysenkoism as a chapter in The Dialectical Biologist (partly intended for their own “self-clarification”—Levins and Lewontin, 1985, p166).

There are two inadequate ways to respond to Lysenkoism—Levins and Lewontin reject both of them. Firstly, many commentators have described the issue as if it was simply a case of

39 Richard Lewontin also met Haldane, who lived until 1964, and Haldane associated with Lewontin’s doctoral supervisor Theodosius Dobzhansky so there were personal connections between the two generations (Dronamraju, 2017).
“ideology” distorting science. For example, science writer Mark Pilkington concludes that: “The Lysenko story serves as a powerful warning against the collusion of ideology and science, a threat that is very much with us today” (Pilkington, 2003). Similarly, one writer in Nature strongly condemns “political intervention” in science, adding that the Lysenko episode: “ought to be seen as an example of the devastating consequences that ideology and excessive political involvement can have on science” (Soyfer, 2001, p724). This view treats science as if it is in itself neutral and assumes it would develop according to its own internal logic if its course wasn’t swayed by external factors such as the actions of malicious politicians. It implicitly rests on the assumption that there is a neutral vantage point from which science produces a picture of a natural world that is “out there”, although the quality of that picture might sometimes be distorted by ideology (Erickson, 2016, p87).

Clearly, given the politics of SftP, an interpretation that treats ideology as simply an obstruction to an otherwise neutral body of scientific thought would be inadequate. For Levins and Lewontin, viewing the rise of Lysenkoism as simply as a result of political interference is not a sufficiently materialist approach to history. It is a reflection of a liberal tendency to see historical change as resulting from the actions of individuals. Writing on the Lysenko issue, they contend that it is not possible to practise science without having an ideology, stating: “we…cannot accept the view that philosophy must (or can) be excluded from science” (Levins and Lewontin, 1985, p165).

Liberal critiques of Lysenkoism also tend to over-simplify the analysis of Stalinism itself. So, rather than developing an understanding of the direction in which scientific policy in the Soviet Union was heading and why its leaders embraced certain viewpoints and silenced others, it treats Stalinism as merely an irrational ideology. Clearly there were malicious individuals and abuses of power involved. But drawing attention to these is not sufficient to explain Lysenkoism. Louis Althusser, writing in 1977, makes this point in his introduction to Dominique Lecourt’s book Proletarian Science? The Case of Lysenko: it is not enough to dismiss Lysenkoism as merely a “personality cult” surrounding someone whose ideas suited Stalin’s despotism or to treat the “affair” as something that has since been “rectified”. Rather, there is a need for a material analysis of the social forces at work that had allowed Lysenko’s ideas to be embraced. For Althusser, Lysenko’s interpretation of dialectics was evidence of the way in which dialectical philosophy itself had been turned into an ontology of laws following the Soviet Union’s reading (or misreading) of Engels’ Dialectics of Nature. At the time of his writing, with the Soviet Union still in existence and its ideas influential on the left internationally, there was a pressing need to address this problematic interpretation of Marxist philosophy even after the more specific debates concerning biology and genetics were over (Althusser, 1977).
The second inadequate response, associated with some scientists of the left at the time of Lysenko, was to make apologies for his views. Some commentators, although critical of Lysenko’s falsification of experimental results for example, neglected to consider whether there was a more fundamental problem with the interpretation of dialectical materialism pursued in the Soviet Union. As Rose and Rose (1972) point out, several British scientists were taken in by Lysenko’s claims. Although it may well be true for example, that vernalisation has some effect on wheat yields, pointing out that some of the ideas peripheral to Lysenkoism were correct misses the point. This kind of apologetics for Lysenkoism represents just as much a failure to fully interrogate the causes of the phenomena as the dismissive interpretation discussed above. It sidesteps the key issue of why the Soviet Union was so willing to ditch Mendelian genetics which was, and is, central to the modern synthesis in biology established by Haldane and others.

Levins and Lewontin instead try to explain why Lysenko and his followers might have been suspicious of the mainstream genetics of their time. A major factor in his success was that he was able to associate “orthodox genetics” with “the racialist views of the Nazis” (Rose and Rose, 1972, p113). Eugenic ideologies, for example the view that “superior” humans might be bred from those people judged to be most intelligent, were common among geneticists in the West at the time and made Western biology an easy object of criticism for the Lysenkoists. Many Western scientists held deterministic views about the role of genes, suggesting that genes completely controlled an organism’s development with little role played by the environment. They subscribed to a strict causal separation between gene and environment, something Levins and Lewontin themselves call into question in their own work. They even suggest that these views of genetics would almost inevitably “invite” an anti-genetics backlash from Soviet scientists (Levins and Lewontin, 1985, p180). Levins points out that Lysenko was “dreadfully wrong, especially in trying to reach biological conclusions from philosophical principles”, but that rather than simply dismissing Lysenkoism “in Cold War fashion”, a more productive approach would be to “respond to his challenge by developing a deeper view of the organism-environment interaction” (Levins, 2007, p366). The following section therefore shows how Science for the People members have developed an approach to the contradictions inherent in practising Marxist science that distinguishes them from the left-wing scientists of previous generations before addressing some of their contributions to biological debates.

5.2: Science as contradictory activity
With the emergence of studies into the sociology of scientific knowledge (SSK) in the 1970s and 1980s (and Science and Technology Studies or STS more broadly), the view that science is a social activity has become more widely accepted. According to SSK, scientific knowledge
itself, as well as scientific practice, is open to sociological examination. However, it was radical scientists themselves who first made these claims; SSK owes a debt to social movements such as SftP and their investigation of the content of science as itself social as well as to earlier pioneers of this thinking such as the Russian scientist Boris Hessen, mentioned in chapter two (Graham, 1985): one reason to study the history of SftP “is its significance in the birth and development of STS… Members of SftP frequently drew from the analyses of STS scholars” (Schmalzer, Chard and Botelho, 2018, pp6-7).

One of the propositions of SSK is the principle of symmetry: scientific ideas perceived to be true should be seen through the same sociological lens as those perceived to be false (Erickson, 2016, pp86-87). A scientific discovery that later comes to be generally accepted as correct such as Oparin’s theory of the origin of life should be understood in its context—as the ideas of a scientist influenced by Marxism—just as Lysenko’s false ideas are attributed to his Marxist influence. As the historian Loren Graham says: “The tendency to explain an acknowledged calamity in science as a result of Marxist philosophy while assuming that a brilliant page in the history of biology has nothing to do with Marxism is a reflection, at least in part, of the biases and historical selectivity of anti-Marxist journalists and historians” (Graham, 1973, p258).

So, if Levins and Lewontin are critical of crude attempts at a proletarian science, how do they propose to relate their work to that of what might be described as “mainstream” biologists? Should the insights of the latter be dismissed wholesale? Despite their critique of scientific claims to objectivity, it seems they would answer “no” to this question. Levins says that “the fact that all science is socially located does not by itself make it true or false” (Sur, 2008, p35).

As mentioned earlier, Lewontin compares scientific work to other forms of work. Levins likewise talks about scientists as workers. But science is still seen as differing from other forms of human activity in that it is about trying to find out the truth: “We are workers in the knowledge industry. The products of our industry, the commodities, knowledge, ideas, theories and so on are sold, marketed and invested in. As a result of this, scientific labour is increasingly carried out by a working class of scientists… There are ways however, in which as workers we are different from other workers” (Levins, 2014). For Levins, scientific workers have a stake in the products of their labour in a way that many other workers do not. So, as well as defending their interests as workers, for example by demanding higher wages or opposing sexist attitudes in the lab, activist scientists are also concerned with contributing to “knowledge about the world” (Levins, 2014).

The fact that science is owned sets its agenda. We started out in Science for the People denouncing the misuse of science. We talked about use and
misuse and we thought that there was a correct way of using science and there’s a bad way that we have to purify the system from. That’s not the case… Our recognition that science is owned is one of the ways in which we not only have a different orientation towards scientific questions but also a more exciting one. I’ve found examples of people whose radicalisation came about through the critique of the content of the science, through recognising reductionism, through recognising the limitation of science, the narrowing of the agenda of science (Levins, 2014).

Therefore, dialectical biologists have avoided the relativism of some approaches to SSK whereby scientific claims are seen as painting equally valid pictures of nature (Erickson, 2016, p87). For example, Hilary and Steven Rose complain that what is sometimes referred to as the “strong programme” of SSK offers nothing to “distinguish true from false theories” (Rose and Rose, 1979, p324). Levins has also referred to the limitations of a kind of postmodern relativism that only goes as far as saying that everyone’s ideas come from a particular perspective without addressing why people hold different ideas (Sur, 2008) and Levins and Lewontin have jointly stated that they reject the “postmodern view” that denies the validity of knowledge (Levins and Lewontin, 2007, p9).

At around the same time that Levins was addressing these issues, feminist standpoint theorists (including Hilary Rose) were developing their own approach to epistemology rooted in Marx’s method. Although there are many debates among standpoint theorists and criticisms to be made of much of their work, suffice it to say here that they argue that women’s life experiences are different from those of men and that this forms the basis of a distinct standpoint from which to observe social and natural relations. However, the emphasis is often on feminists’ differential ability to reveal the real social relations behind ideology rather than on philosophical relativism (Hartsock, 2004 [1983]). Rose argues for a feminist critique of science that acknowledges the role of capitalist and, in this case, “masculinist” ideology in producing scientific knowledge but is clearly against the “antipathy to science that rejects all scientific investigation” (Rose, 2004 [1983], p67). Rather, she calls for the building of a feminist science that fuses women’s subjective knowledge with objective knowledge (Rose, 2004 [1983]).

Similarly, in place of relativism Levins has put forward an alternative view of the relationship between science and ideology that expresses the contradictions inherent to scientific enquiry. He often states that: “all science is class science yet science also finds out real truths about the world” (Levins, 1981, see also Sur, 2008). Levins admits that this is a contradiction; if science
in a class society is inseparable from class interests, how can it also be true? But, importantly, Levins continues by arguing that “you don’t resolve contradictions…”:

The resolution of the contradiction between science as the growth of human knowledge and science as ideology of oppression comes only with political revolution. The break from radical philosophy to Marxist dialectical materialism is the recognition that contradictions aren’t resolved by intellectual exercise. Rather, you recognise those contradictions, examine them, understand them, fight them, participate in them (Levins, 1981).

For Levins, the truth of scientific claims and the non-objectivity of those claims could be held in tension with neither seen as more important or more worthy of attention. Yih adds that Levins’ “single contradictory proposition” informed and guided SftP as activists. They were critical of the dominant ideologies guiding science but also at the same time recognised the power of scientific knowledge, hence they wanted the tools available to scientists to be shared with humanity or “the people” (Yih, 2014).

What does Levins’ approach to science’s contradictions mean for debates about scientific ideas? Most significantly, it means science becomes more than merely ideology (Sur, 2008). It isn’t only the purpose of science that radical scientists should take seriously (Levins calls such a position “a false view”), it is also the content of science that is open to examination or to challenge, this is Levins’ more exciting orientation towards scientific questions (Levins, 1981). In this Levins echoes Engels, who also, by discussing contemporary scientific questions in his Dialectics of Nature, advocated for the contribution of Marxist or dialectical ideas to debates within science as well as its uses.

Levins’ use of contradiction here echoes the points made by David Barnett, referred to in chapter two in a discussion of post-Brechtian theatre. Like Levins, Barnett stresses that dialectics does not deal in resolution of contradictions and sees such an emphasis on commensurability as itself an aspect of bourgeois thought (Barnett, 2013). To return to the case study with which this thesis began, the case of forest conservation and the northern spotted owl, Levins’ contradictory approach to science hints at a way forward for thinking about environmental problems such as this. Perhaps, following his example, we should argue that the forests and the species that live in them are socially produced, but simultaneously, when considering real biological species, they should be understood as real material beings with their own attributes that cannot be understood purely with reference to the human. This provides a contradiction; but perhaps it is a real contradiction that should be held in tension and cannot (and shouldn’t be) resolved.
Furthermore, in their collection of essays *Biology Under the Influence* (2007) Levins and Lewontin talk about the “dual nature” of science: “on the one hand, science is the generic development of human knowledge over the millennia, but on the other it is the increasingly commodified specific product of a capitalist knowledge industry” (Levins and Lewontin, 2007, p9). Out of this contradiction what has emerged is, in some ways, an impressive level of sophistication of biological knowledge. Modern biology, with programmes like the Human Genome Project, has produced an extraordinary amount of information about the living world. But at the same time, science in a capitalist society has developed with its own internal limitations causing it to reach an impasse (see Burkett, 2014, pp158-163). It has resulted in an approach to biological theory that sees the parts of a system rather than the whole, that see stasis rather than dynamism and that separates what should be connected. The reductionist tendency to separate processes that could be viewed as dialectically related puts obstacles in place of its ability to make sense of all this data. As will be explained in this chapter, the dialectical biologists have countered the predominant reductionist views in biology with their own contrasting approach, providing what Levins describes as a “counterweight” to the still prevalent reductionism (Levins, 2007, p367).

5.3: Metaphors

A further related theme that emerged from the interviews with scientists was that they often made use of metaphors. The use of metaphors and the ways in which different metaphors can conflict with each other further highlights how radical scientists are able to make realist statements while at the same time avoiding claims of objectivity or neutrality. Once seen as a rhetorical device for use in literature, the fundamental importance of metaphor to scientific thought is now much more clearly understood. Metaphors are indispensable for conceptualising ideas and communicating findings; allowing the unknown to be “seen through the lens of the known” (Nicholson, 2014, p162).

Metaphors are so essential to science that David Harvey refers to them as “the primary means whereby the human imaginary gets mobilised to gain understandings of the natural and social worlds (Harvey, 2006, p163). As Harvey explains, the prolific use of metaphors by scientists makes it difficult to extract “socially untainted information” from the metaphor and shows how the choice of metaphors can often reveal something about the social position of the scientist. As an example, Charles Darwin uses the concept of a niche to suggest a division of labour among species where each has a distinct “role” to play in an ecosystem. Harvey (2016, pp159-164) supposes that this reflects Darwin’s knowledge of the factory-based production of his time (his grandfather was the industrialist Josiah Wedgwood). As Harvey stresses, if ideas
about nature import ideas about society, this means that projects that try to use the natural sciences as the basis on which to argue for a particular type of society are misguided.

Biological metaphors have often been superseded by newer metaphors when viewed as no longer appropriate. For example, neuroscientists have tended to focus their interest on neurons, the cells in the brain that transmit electrical signals. Glial cells, closely associated with the neurons, were considered to play a supporting role and were referred to in terms associated with traditionally female gender roles such as being described as “nursemaid” cells or “housekeepers”. When the importance of these cells in brain formation was recognised, they apparently lost their feminine characteristics, subsequently being described as the “architects of the brain” (Upchurch and Fojtová, 2009).

Nicholson points to one metaphor that has played a particularly limiting role in biology; the notion, associated with Descartes, that organisms are like machines (Nicholson, 2014). Clearly a living organism is made up of parts that have evolved and therefore appear to be designed for a function, for example the mammalian heart pumps blood around the body through the arteries in a manner analogous to the way a mechanical pump circulates fuel through an engine. To some extent it is therefore useful to think of organisms as machines, for example when teaching basic anatomy to students. However, the machine concept also produces limits to understanding. Organisms are fundamentally different from machines in several ways. Importantly, living organisms do not serve the purpose of an external designer or engineer, they act on their own behalf and can be described as self-organising. Secondly, unlike in a machine where each part of the whole has its own distinct properties, the different parts of an organism cannot be considered as independent of the whole. Each part has developed within a whole organism and the parts rely on each other for their maintenance and renewal (Nicholson, 2014). Likewise, the Marxist biologist Steven Rose, in a discussion of animal rights, rejects the Cartesian notion that non-human animals are like machines (for Descartes this was because other animals do not possess a soul). Rose sees the treatment of animals as mere objects to be exploited by human subjects as a form of reductionist thinking (Rose, 1992). As explained in chapter three, dialectics and new materialist thought are often contrasted. However, in questioning the machine metaphor, Rose pursues similar strategies to that of the new materialists by refusing to accept that the human body is inert until it is enlivened by an external impulse.

This use of metaphor is common to both mainstream and dialectical approaches to biology. As with the machine metaphor above, metaphors can limit understanding as well as enabling it. And, according to the principle of symmetry described above, “good” metaphors should be critiqued on the same basis as “bad” or unhelpful metaphors are criticised.
5.4: Contributions from dialectical biology

As the previous sections explain, the dialectical biology developed by the radical scientists of SftP and their followers should be understood in the context of an approach to scientific enquiry that recognises and accepts that science is itself contradictory. It aims to find truths about the world but at the same time those truths are not arrived at from a position outside of society. The remainder of this chapter will discuss some of the substantive contributions for which the dialectical biologists are best known.

Many of the scientists interviewed here referred to “complexity”. However, it became clear while carrying out the interviews that there are distinct ways of understanding what a term like complexity means. It may refer to a property of the object of study. For example, an ecologist researching a particular ecosystem might say that there is a “complex” and interconnected web of species living there or that emergent properties of the system result from this complexity. However, they might also use this terminology to describe the way in which they work, for example by stating a preference for observing a particular species in situ rather than in the lab—not treating it as separate from its surroundings. They might say that they see the “bigger picture” that reductionist thinkers fail to see. The interview responses were therefore divided into statements about the object of study and those about the act or process of observation.

This distinction between subjective and objective references reflects the ongoing debate about whether dialectics is an ontology—a statement about how the world is—or an epistemology—a comment on how we might think about the world. As Castree points out, in some interpretations dialectics is assumed to mean that reality is seen as possessing certain dialectical properties, while in others it is viewed more as a method of research or as a way of representing reality (Castree, 1996). However, Castree also states that there cannot be “any clear separation between the two positions” (Castree, 1996, p345). And clearly the two understandings of complexity in the example above are internally related. The emphasis a biologist places on complexity in the way they choose to carry out their work might enable them to better understand those properties of the world they are studying.

Furthermore, taking a non-dualist and dialectical position means rejecting any attempt to draw a clear distinction between an external “nature” and the humans observing it. As explained in the previous section, such distinctions—between what is internal to science and what is external; between its content and its social role—should themselves be called into question. And, in an Anthropocene epoch, where nature itself is continually being manipulated by human activity in multiple ways, it makes little sense to treat scientists as if they encounter nature from the outside. What is needed is an approach to the study of science that recognises the contradiction between the content of science and its social role or purpose. As Ollman also
argues, ontology and epistemology are themselves internally related in his dialectical approach (Ollman, 2014, p574).

To further illustrate the point, Steven Rose gives an example of a single event, in this case a frog jumping into a lake, with multiple causes that cannot be separated out (Rose, 1997). A group of scientists observing a frog jumping might come to different conclusions about why the frog jumps. An ecologist might argue that it is reacting to the presence of a snake and its instincts tell it to escape (the ultimate cause) whereas a physiologist might say that the interaction between the actin and myosin filaments in its legs cause its muscles to contract resulting in a jumping action (the proximate cause). Clearly neither is wrong about why the frog jumps into the lake—but they are asking very different types of questions about the causes. Rose’s example suggests an approach whereby ontological and epistemological claims are themselves dialectically linked. Multiple causes of an event are assumed to be present in reality regardless of who observes the event. However, the specific causes that one finds interesting or chooses to focus on evidently have a lot to do with the identity of the observer. Harvey’s notion of dialectical methodology being about the same process looked at through different windows depending on who is observing seems a particularly apt way of interpreting the situation (Harvey, 1982, see also Castree, 1996).

Levins and Lewontin refer to dynamic processes, complexity and “complex webs of reciprocal determination”. They contrast their view with one that looks for singular causes of a phenomenon and that “treats what is variable as if it were constant and even universal” (Levins and Lewontin, 2006, p333). In their 2006 “Program for Biology” they make three statements about their dialectical method, that “the truth is the whole”,40 that “everything is not relevant to everything else”, and that “history matters”. This remainder of the chapter outlines how these principles are expressed in the work of the biologists interviewed.

5.4.1: The truth is the whole

Criticisms of gene-centric thought in “mainstream” biology are common among the dialectical biologists.41 For Levins the emphasis on the information coded in the genes in much of biological theory is symptomatic of science under capitalism in that it attempts to explain a

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40 The phrase “the truth is the whole” comes from Hegel’s Phenomenology of Spirit (see Callinicos, 2010, p78). The statement was considered so important to Richard Levins’ worldview that it also provided the title of a conference in honour of his 85th birthday in Harvard in 2015.

41 Conventional biology as described here is sometimes referred to by its critics as neo-Darwinism. However, there is a radical interpretation of Darwin’s own views as well as a conservative one so here I avoid reference to Darwin and refer to a modern synthesis or to mainstream biology in contrast to an extended evolutionary synthesis.
world that is both dynamic and complex by reducing it to its most basic and stable units. So, in evolutionary theory the changes in organisms through time are understood solely as a result of the shuffling around of different genes which are themselves viewed as “truly unchanging and stable” (Levins, 1981).

For biologist John Parrington, one reason why biology has become so gene-centric “may be the pervasiveness of the ideology of bourgeois individualism within capitalism. This states that any complex system is best viewed as the sum of its individual components” (Parrington, 2013, p104). The idea that the main focus of biology could or should be on the information stored within the genetic code is seen as symptomatic of a legacy of thinking about biological systems analogous to the way capitalist economics treats people—as independent and individual elements that merely interact with each other (“there is no such thing as society”). As Levins further explains, as the profit incentive has become more central to scientific research this has resulted in greater specialisation among scientists; a greater focus on very specific aspects of the natural world. Someone working in the pharmaceutical industry, for example, might only be interested in the active ingredient of a plant with medicinal properties rather than the organism as a whole (Levins, 2014). But, alongside this need to commodify the products of scientific expertise, when practised in a capitalist society there is also an ideological drive towards reductionism (Rose, 2012).

Reductionism suggests that phenomena within ecology can be explained using ideas from physiology, which can themselves be reduced to molecular biology and so on down to subatomic physics. Processes at the “lower” levels—those described by physics—tend to occur at smaller spatial scales and to be more universally applicable; physics applies to all matter whereas ecology only applies to living things (Rose, 1997). An extreme version of reductionism was taken up by James Watson, responsible with Francis Crick for describing the molecular structure of DNA, who reportedly stated that “there is only one science, physics; everything else is social work” (in a 1996 debate with Steven Rose, quoted in Rose, 1997, p8). In contrast to such ruthless reductionism, approaches influenced by dialectics have stressed the role of multiple causes of biological phenomena acting at different levels.

Relatedly, dialectical biologists have often spoken in terms of opposition to deterministic explanations. Levins and Lewontin give a simple example of why: a determinist thinker might say that because pests kill plant crops, using a pesticide will protect those crops. However (as is by now well known) there can be unintended consequences of using pesticides, including that they might kill the predatory animals that would eat those same pests, actually contributing to pest outbreaks. Levins and Lewontin maintain that avoiding “unidirectional causation” and making multiple causation and non-linear processes central to their worldview cuts against common sense ways of thinking about biology (Levins and Lewontin, 2006,
Similarly, an organism’s genotype or genetic make-up is often thought of as determining its phenotype in a one-directional way. Crick even referred to this one-way flow of information as the “central dogma of molecular biology” (Parrington, 2015, p39). However, dialectical biologists are often very critical of the assumption that an organism’s genetic make-up determines what it will be. Instead, they point out, there are multiple contingent processes that occur inside a cell that influence how a protein is produced.

As Rose points out, although it is commonplace to state that there is a gene “for” brown eyes in humans, the actual mechanism by which possessing this gene leads to a person developing a brown eye colour involves a more complex process than this implies. The cells in a human iris must contain certain pigments to appear brown (in their absence the person will have blue eyes), but these are produced in a sequence with multiple stages involving different enzymes transforming one chemical to another. To produce each of these enzymes the information encoded in a gene must be transcribed and translated into protein form by a mechanism itself involving further proteins whose role is to carry out this translation process (Rose, 1997, pp113-116; Rose, 2012). In order to understand this a materialist approach is needed rather than one that, in an idealist manner, sees information as the primary cause of something happening. Meloni draws attention to the problematic view of genetics as providing a basis for understanding human action and points out that biologists themselves seem to be moving towards placing greater emphasis on the context in which genes operate (Meloni, 2014, p732).

In a radio interview, biologist Stuart Newman criticises genetic determinism, and especially the idealist tendency to refer to genetic information in terms borrowed from computing. Relating to the discussion above about the use of metaphor in biology, this emphasises that metaphors can provide limitations to knowledge:

If you have a computer and you want the computer to do something you have to write a program, or you buy a program and it instructs the computer to carry out certain steps under specified conditions and therefore you could say the program determines what the computer does...the idea takes hold that genetic determinism—that is that all important features of a living system are determined by the genes and that other determinants are subordinate to what the genes do. I would say that’s not really the case, even though many people

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42 Human eye colour is relatively well understood. Biologists are on much shakier ground if they propose that there is a gene “for” violence or that sexuality is coded in the genes. All a gene can do is specify a particular protein for the body to produce so it is unclear what proteins such genes would code for and by what mechanisms the proteins would cause particular behaviours to be expressed.
believe it and even scientists write as if it was the case (Newman and Cohen, 2014, emphasis added).

This quote demonstrates that it is possible for scientists to make realist claims while still recognising that their understanding is structured by metaphor. Newman, above, refers to what is or is not “really the case” rather than suggesting that there is no objective reality beyond metaphor, while also recognising that metaphors channel and delimit understanding.

Martha Herbert’s own opposition to reductionism comes across in her critique of approaches that treat the gene as something that operates independently of the other molecules around it. Herbert, a neuroscientist who spoke at the Science for the People conference in 2014, wrote a book chapter on “Marxism and Biology” while working with Richard Lewins 30 years previously (Herbert, 1984). Explaining her differences with “mainstream” thinkers, she says:

It’s amazing how many of my mainstream colleagues don’t have a problem with thinking that a specific gene can determine specific behaviour whereas the way I look at it, you know a gene creates lots of proteins that it regulates and proteins get involved with tissues and the tissues interact and then there are emergent properties because of the chemical changes which interact with the environment (interview, 12 April 2014).

Herbert feels strongly that neuroscience has focused on neurons at the expense of other aspects of brain architecture and that the conventional approach has abstracted these cells from their surroundings. This is particularly evident in representations of the neuron both in textbooks aimed at students and in other media such as advertising where the neuron is pictured as if it is surrounded by empty space. For her this imagery constrains and delimits the “way we like to think” about the brain. She argues that the brain should be seen as a “wet organ”; the fluid that surrounds neurons as well as the other cells (including the aforementioned glial cells) results in material properties that cannot be understood by treating the neurons as if they exist in isolation.

More recently, John Parrington, making the previously under-acknowledged complexity of the genome central to his work, suggests, like Herbert, that genetics requires a more materialist analysis than treating genes as if they simply determine behaviour (Parrington, 2015, see also Royle, 2016). Writing in terms of emergent properties of complex systems, Parrington explains that there has recently been a paradigm shift in how we think about genetics (2015, p201). A reductionist approach, which breaks a system down into its constituent parts and treats each in isolation, has reached the limits of its usefulness. For example, thanks to the Human Genome Project (HGP), the sequence of bases (like letters in a code) that make up the human genome is
now known. But, although Parrington is somewhat sympathetic to the HGP (Parrington, 2013), he sees it as too simplistic to treat the genome merely as one long line of code. Rather, genes ought to be thought of as material entities engaged in a complex relationship with the apparatus in the surrounding cell. For example, the three-dimensional structure of DNA matters. When DNA forms 3D structures some parts of the code are exposed to the rest of the cell where they are “read” while others are hidden (Parrington, 2015, p107). Commenting on the long-standing debate around whether nature or nurture is more influential to human development, Parrington says that it is neither one nor the other, but rather, what emerges from the interaction between genes and the environment ought to be emphasised: “the old division between nature and nurture appears far more fluid than previously suspected” (p173). In summary, opposition to reductionism has been central to dialectical work in biology.

However, as Levins and Lewontin (2006) point out, just because the truth is the whole it doesn’t mean that it is possible, or desirable, to study the whole of the world at once. There needs to be some method of deciding which aspects of a totality are relevant to a particular analysis and which factors can be treated as having a negligible effect on the phenomenon under analysis. Like other scientists, dialectical biologists work with models that describe only particular aspects of a wider system. Here, Levins and Lewontin invoke Ollman’s method of abstraction, a way of momentarily bringing one dynamic into view in order to examine it (Levins and Lewontin, 2007, p186). Dialectics is therefore not simply a crude holism, as evolutionary theorist Julio Muñoz Rubio explains, it is not concerned “with a search for the relations of everything with everything in every moment, but with the relevant set of elements interpenetrated in specific moments or periods, and in the transitions among them” (interview, 5 December 2015).

However, this process of abstraction is itself a matter of judgement and the factors taken into account by a biologist who is a political activist may well be different from those that others prioritise. For some, blood sugar levels in humans might be seen as an essentially physiological issue. For Levins and Lewontin, factors such as whether those humans are exhausted factory workers, whether the foreman is pushing them to work faster and whether they are in a union also affect their blood sugar (Levins and Lewontin, 1985, p194). For these biologists, it is “not too far-fetched to speak of the pancreas under capitalism or the proletarian lung” (Levins and Lewontin, 2007, p37).

5.4.2: History matters

Besides an opposition to reductionism and determinism, notions of change and dynamism are absolutely central to the work of the dialectical biologists. These theorists are not merely
interested in the ways things are, but in how they got that way: What processes led to things becoming the way they are? And how might these processes play out in future? (Levins and Lewontin, 2006, p335). Levins and Lewontin state that they start from the position that the world is fundamentally dynamic rather than starting with static objects and seeking to understand how they change. The dialectical thinker “regards constancy as the normal condition, to be proven otherwise” (Levins and Lewontin, 1985, p277). Agro-ecologist Ivette Perfecto agrees that: “things are constantly changing” (interview, 22 September 2014) and Julio Muñoz Rubio defines dialectics in this way: “dialectical method, more specifically materialist dialectics, is a conception that radically seeks for explanation of the phenomena in the world (be they social, economic or biological) as movement, as historical transitions, as wholeness” (interview, 5 December 2015). In this the views of these biologists are consistent with the emphasis on dynamism common to Ollman’s interpretation of dialectics (2003) and Harvey’s (1996)—which is of course to be expected as Levins and Lewontin are one of the latter’s key reference points.

Levins has stated that “because [dialectical materialism] wants to overturn the existing order, change becomes the central object of interest” (Levins, 1981) and the emphasis on dynamism is one of the most obviously political elements of the approach to biology laid out here. It is capitalism’s apologists who treat existing social relations as fixed, dialectical thinkers seek an understanding of the potential for change inherent in those relations. Here, their views clearly align with those of Marx, for whom, as stated in chapter two, dialectics “includes in its comprehension and affirmative recognition of the existing state of things, at the same time also, the recognition of the negation of that state, of its inevitable breaking up; because it regards every form in the flux of movement, and therefore takes into account its transient nature not less than its momentary existence” (afterword to the second German edition of Capital—Marx, 1976, p103).

Some of the common metaphors in biology can give the impression that living things have always existed in their current state. Take for example the term “knockout” mouse. A knockout mouse is one that has had an individual gene deactivated. These animals can therefore be used by scientists as models to understand what removing that gene does and therefore what role the gene would play were it to be present (National Human Genome Research Institute, 2015). However, an adult mouse has around 10 billion cells in its body, with each containing its own copy of the mouse genome. The image invoked by the term “knockout” mouse, of a scientist taking an adult animal and “knocking out” the unwanted gene from every one of those cells simultaneously is clearly ridiculous. In reality, the gene is

43 As the mouse genome was sequenced in 2002 and is fairly well studied it is possible to select a particular gene for removal with some precision.
removed from a single cell, a stem cell from a mouse embryo, and the resulting mouse will have lived without that gene throughout the whole period of its development. Therefore, rather than asking “what happens to this mouse when gene x is removed?” scientists are really asking “in what ways has this mouse developed from an embryo when it never had gene x?”

Similarly, in ecology dialectical thinkers have pointed out that ecosystems, as we observe them, are not necessarily in their final phase but that their composition may continue to change over time. For dialectical biologists this dynamism results from the actions of the organisms within the system transforming their environments rather than from a factor external to the system that impacts on it from without (such as a fire or flood). In other words, an ecological system is assumed to be dynamic rather than the assumption being of stasis until the system is perturbed (Preston, 2003, p54). Here again the critique of the distinction between external and internal pressures is evident as dynamism can emerge from processes internal to the ecosystem and there is no need to invoke a separation between the system and its outside. This is also one of Harvey’s examples of biological metaphors. Harvey notes that many ecologists seem to be looking for examples of harmony and security—the conclusion of a process—in biological systems (Harvey, 1996, p163). By contrast dialectical thinkers tend to emphasise disruption and open-ended processes that are not resolved.

Beyond stating that “everything changes” there is also a need to make sense of the nature of that change. Dialectical thinking lends itself to considering the ways in which a complex system develops through time and goes through irreversible changes. In other words, there is a particular understanding of change involved. For example, Chris Sinha refers to living systems as “dynamically developing systems…you can’t treat the growth of organisms as if it’s an instantaneous process—as if it’s blueprinted from the start. It’s not” (interview, 19 August 14). For dialectical thinkers, time is not thought of as separate to the material world, a distinction established in Cartesian thought. Rather historical development is inherent to what happens to the material world.

To illustrate this idea, it is useful to consider how dialectical biologists think about the ways in which organisms relate to their environments. These ideas will be developed further in the next chapter which addresses ideas of non-human agency as developed in biology. But the ways in which organisms react to their environments also relates to how evolution is understood. Darwin implied that the environment in which a species finds itself drives evolution in a particular direction. This is analogous to the way in which a spherical ball placed on a table can roll freely in any direction. A species could, in theory, become anything that the environment pushes it towards becoming. In contrast, Gould, referring to the work of Darwin’s cousin Francis Galton, has likened the constraints acting on evolution to those imposed by a polyhedron with multiple flat sides. A polyhedron, once pushed in one direction will “push
back”, it can roll onto another of its sides but only when pushed with enough force and only then in certain directions. There is an interaction between the capacities of the organism itself and the force applied to it (Clark and York, 2005a). Dialectical biologists, Gould in particular, have argued that the material aspects of an organism impose these constraints on how it evolves: “Organisms are not mere putty to be sculpted over the course of their phylogeny (evolutionary history) by external environmental forces, but, rather, their structural integrity constrains and channels the variation on which natural selection operates” (Clark, Foster and York, 2007, p539; see also Blackledge, 2002, p10). These restrictions on the freedom of evolution to act come from the internal characteristics of the organism.

5.4.3: Materiality
This leads to the question of what these characteristics of the organism might be. The previous sections have suggested that, far from neglecting to address the material properties of the things of the world, as the new materialists suggest, the dialectical approach outlined here is thoroughly materialist. This is further illustrated here by the work of Stuart Newman, a professor at New York Medical College and associate of Levins and Lewontin. Newman’s work illuminates how he understands the development of, in this case, the animal form. It also demonstrates the focus on the material properties of the non-human world in his work. Newman specialises in evolutionary developmental biology or “evo-devo”. In other words, he researches how the processes involved in the development of an organism from embryo to adult evolved. Evo-devo integrates the insights of ontogeny (development of an individual during its lifetime) with phylogenetic development (changes occurring through the generations by evolution). It also seeks to understand how ontogenetic processes can in turn influence evolution. Newman sees his own field as inherently dialectical (“development so obviously lends itself to thinking in dialectical terms”—interview, 17 March 2014) in part because evo-devo integrates approaches that had previously been seen as separate (Newman, 2007).

Like many of the biologists discussed here, Newman doesn’t reject the theory of evolution but is critical of the over-emphasis on genes as a causal factor in development common to much of mainstream biology.44 One of his key contributions is the insight that embryos have an innate tendency to produce certain forms due to the physical characteristics of animal tissues and that this has implications for evolutionary theory. As he explains, in the (mainstream)

44 Newman is profiled on the website www.thethirdwayofevolution.com which advocates for an approach that incorporates knowledge of other processes beyond natural selection in evolutionary theory. This third way is neither limited to a strict application of the modern synthesis nor a detour into creationism, therefore it might also be described as materialist but not a mechanical materialist approach.
“populational biology version of Darwin’s theory” there is an assumption that a population of organisms, confronted with a problem posed the environment will either evolve to solve that problem or will die out. There are no inherent “constraints” on evolution. This approach aligns with a gene-centric position as it is mutations in the genes that provide the mechanism for the organism to freely evolve to “fit” its environment (interview, 17 March 2014). So, organisms are treated as almost infinitely malleable in terms of how they evolve and as essentially passive, they react to an environment that confronts them as an external force.

By contrast, taking into account the *material* properties of animal bodies hints at quite a different view. In animals, biological tissues are made up of aggregates of cells. For Newman, these tissues have certain capacities. He uses the example of vertebrate segmentation to explain how biologists could understand dialectically the relationship between processes internal to a body and external to it as occurring within an animal as it develops through time. There is a tendency for animal tissues to form segments (serially repeated units) during development and these are found in the bodies of various animals including worms, insects and vertebrates (in the latter, the vertebrae that make up the spine provide one example of segmentation). This tendency towards segmentation is now explicable with reference to the relationship between the attributes of cells in the animal tissue and signals that the tissues receive (Baker, Schnell and Maini, 2006).

In the “clock and wave-front” model, cells oscillate in unison between two states, one where they are capable of forming a somite (a block of cells that will go on to form a body segment) and one where they do not have this capacity. As they oscillate between states a chemical signal travels down the length of the animal’s body at a particular pace. As it reaches a section of tissue with the capacity to form a somite it will do so resulting in an alternating pattern of segments along the length of the animal’s body (Newman, 2007). The exact details of this process are still debated (Baker, Schnell and Maini, 2006). However, from the point of view of understanding Newman’s dialectical insights, the important aspects of the process are that the development of segments arises out of an *interaction* between the material properties of the animal cells and the influence of a chemical signal. Rather than an organism responding to its environment in a unidirectional way the form of an organism arises from a reciprocal relationship between the environment, organism and genes—mutual causation is also involved. And, rather than being “passively moulded by the problems it encounters” the properties of organisms themselves influence evolutionary processes (interview, 17 March 2014).

Initially trained in physics, Newman describes how his background encouraged this interest in the material properties of animal tissues: “Tissues…in some ways are like liquids and, in some ways, are like elastic sheets. They have an inherent propensity to take on certain forms so it’s really not such a puzzle when you think about the physics involved” (Newman and Cohen,
In a recent book he explains, in terms not dissimilar to Bennett’s descriptions of the properties of metals and other substances, how the tissues of animal embryos have liquid-like properties and, in some ways, behave like viscous liquids (Newman, 2014). Indeed, Newman often uses the analogy of water to describe the way the properties of a substance constrain what that thing can do. Molecules of water have specific properties of their own. When they are aggregated, a pool of water has emergent properties not found in the individual molecules—but these properties are not limitless:

If we want to build things out of liquid water we can’t build anything. We can make waves and we can make whirlpools and we can make just a limited number of things because that’s the nature of the material and we just can’t, we can’t make very complex sculptures with liquid water. Similarly, with biological tissues and the fact that we see that a lot of organisms have segments or they have interior cavities or they have appendages. That is what this kind of material can do…[evolution] can’t really go beyond that kind of thing (interview, 17 March 2014).

These physical properties of animal tissues predated the evolution of genes “since physics is older than genes, it actually suggested ways of looking at the evolution of form” (interview, 17 March 2014). In other words, the forms of animal bodies might have come about in part due to the constraints imposed by animal tissues rather than merely being produced by the trial and error process of natural selection. If biological tissues exhibit a “preference” for forming particular shapes or patterns this suggests to Newman that the evolution of particular body plans could have occurred at a faster pace than might be supposed if only natural selection were involved. Newman has also referred to matter as having “self-organising” properties: “In those cases where matter, either spontaneously or by interaction with other matter, arranges so that it is self-sustaining or self-organising then those are the things that draw our attention. And the first life forms were these self-organising entities” (Newman and Cohen, 2014).

As Newman explains, his knowledge of Marxism—and particularly its emphasis on the potential for change contained within the conditions of the present—“prepared” his mind for his work in evolutionary developmental biology:

My mind was already prepared for that because I was an activist in the 1960s and 70s and had the good fortune of having kind of senior colleagues and teachers—people like Richard Levins and Richard Lewontin… Basically Marxism is about the development of social formations. And it tries to understand the historical development of societies but you have a kind of a transformation of each society. You can
see the connection between what goes on contemporaneously in a given society and tendencies for it to change for the future and evolve into something else (interview, 17 March 2014).

He goes on to describe how his tendency to think in terms of organisms developing over time led him away from a deterministic view of genes being “in control of everything”, although he accepts that genetic influences play an important role: “there are some very essential individual components to these complex wholes [i.e. genes] that can’t be dispensed with, [but] nonetheless they are not the entire causal principle of the complex structure”. Newman sees evolution in terms of multiple determinants where development can be influenced by processes from the bottom up as well as from the top down. This is somewhat analogous to the way in which a society influences individuals as well as individual people influencing the societies in which they live. Although the processes at work in a human society are clearly different to those in a developing embryo, there are similar principles involved: “This is really a contribution of Marxist philosophy” (interview, 17 March 2014).

However, despite the emphasis on materiality that Newman shares with some new materialist thinkers, he is dissatisfied with philosophical approaches that adopt a flat ontology. Citing various examples of what he refers to as “biological postmodernism”, he argues that the view that: “there are no essential differences within nature, no absolute differences between minerals, vegetables, animals and humans. Rather, matter is a vast continuum” (Thompson, 2005, quoted in Newman, 2009) is typical of such postmodern thinking. For some, it doesn’t make any difference whether something is organic or inorganic, natural or artificial—it is all made up lively matter. Newman argues that this view has become the mainstream within biology and has started to affect policy making; the US Department of Agriculture based their arguments on this philosophical position when they employed the notion of “substantial equivalence” in 2000 to propose that genetically modified (GM) foods were really no different from those bred by traditional means (Newman, 2009). Newman contends that there are indeed real biological differences between crops bred traditionally and those produced using gene splicing techniques that are obscured when both are viewed merely as different instances of lively matter. This highlights one of the problems with new materialist thought raised in chapter three. That it tends to emphasise the properties of isolated things as they exist in the present while obscuring the processes that brought those things into existence. For critics of GM food such as Newman, the history of how a food product was produced is important as well as its material properties.

If organisms simply reacted to pressures from the environment to evolve in a certain direction we might expect evolution to be smooth and gradual. However, if we accept the view that evolution is more like trying to roll a polyhedron with flat sides across a table, then we might
expect evolution to be typified by long periods of stasis punctuated by abrupt change. This is indeed what Stephen Jay Gould and Niles Eldridge proposed with the theory of punctuated equilibria. They pointed out that, rather than being characterised by “stately unfolding”, evolution involves long periods of stasis interspersed with instances of “rapid and episodic events of speciation” (Eldredge and Gould, 1972, p84). Although initially controversial, Eldredge and Gould explained in a later paper that the theory had become generally accepted among their colleagues (Gould and Eldredge, 1993). The theory of punctuated equilibria is a relatively well-known example of dialectical biology. However, what is not always appreciated is how central the dialectical view of the organism-environment relation is to the theory. The theory takes account of the ways in which the material properties and capacities of living things influences evolution.

Evolution by punctuated equilibria has been viewed as an example of a shift from quantity to quality; small quantitative changes build up over a relatively long period of time until there is a sudden break and a new, qualitatively different, form emerges (Callinicos, 2006, p213). Gould himself hinted that his views on the subject were influenced by the dialectical approach of Hegel and Marx and the emphasis they place on transitions from quantitative to qualitative change (Gasper, 2002). However, Levins and Lewontin caution that: “The temptation to see some simple connection between Steve’s theory of episodic evolution and his adherence to Marx’s theory of historical stages should be resisted” (Levins and Lewontin, 2002). Instead of relying on a strict analogy between Marxist theories of history, Gould worked with a deeper understanding of change and contingency.

5.5: Conclusion
This chapter has discussed the work of a small group of self-described “dialectical” biologists. It has demonstrated how their approach has arisen with the radical science movements of the late 1960s onwards, most famously with Science for the People in the US. Crucially, the approach of this generation of scientists differed from that of their predecessors in that, faced with the militarisation of science, they were unable to treat science as a source of good or neutral information that merely needed to be harnessed to the right cause (Rose, 2004 [1983]). By contrast, as Zimmerman and others state (in what is effectively a manifesto for Science for the People): “science is inevitably political” (Zimmerman et al, 2018 [1972], p16). For Hannah Holleman, a social scientist who appreciates their work, the key insight of the dialectical

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45 The authors maintain that this is a result of the reality of evolution and not just an artefact of the incompleteness of the fossil record (Eldredge and Gould, 1972).
biologists is their recognition of “the role of philosophy, theory, ethics and worldview in the practice of science” (Hannah Holleman, by email 3 January 2018).

This chapter has shown how the scientists associated with this movement recognised the internal contradiction inherent in discussing the social role of science and its content whereby one cannot be understood without reference to the other. They have opened up the very content of science to critique. As Herbert (1984) explains, the radical scientists of the 20th century were able to come to substantial conclusions within the theory of biology as well as critiquing what they saw as inappropriate, unfounded or wrong applications of science. They have put forward a strong critique of reductionist and determinist thinking and have posited that history matters to our understanding of the biological world (Levins and Lewontin, 2007). As well as drawing attention to the implicit dualism that separates the content of science from its context, they have also recognised that dualism pervades biological thought and have opposed theories that separate time from matter, organism from environment, nature from nurture, ecology from evolution and nature from society. Dialectical biology is an attempt to avoid both reductionism and holism and to be materialist without being mechanical.

Like any scientists, dialectical biologists are of course fallible. Therefore, the coverage given to their work in this chapter is not intended to prove all of their theories correct. Some theories were initially controversial but have now been accepted, others are still disputed, yet others will doubtless be rejected at some point in the face of new evidence. However, my interest here is in the underlying logic to their approach to biological questions that can give an insight into what dialectics means in practice. As Harvey argues, as dialectics is inherently a critical philosophy it is often more appropriate to demonstrate dialectics by starting with the concrete—working through real world examples of it rather than starting with an abstract concept: “the only way to understand [Marx’s] method is by following his practice” (Harvey, 1996, p48).

This raises the question of the extent to which the work of these scientists is dialectical. This is not a simple question to answer. Levins and Lewontin describe their reluctance to put forward a set of laws of dialectics as Engels seems to have attempted. In their words, such an approach is a “vulgarisation of Marxism” (Levins and Lewontin, 1985, p183) that contradicts “the fluidity and historicity of the Marxist worldview” (p267). In place of such a rigid outlook, Levins and Lewontin state that dialectics is instead a reflection of “certain habits of thought, certain forms of questioning” (Levins and Lewontin, 1985, p267). As the name of their book The Dialectical Biologist suggests, they were not trying to create a dialectics of biology or to apply a dialectical method to the subject from without. Rather, they argue that they had adopted dialectics as a method and incorporated it into their practice as scientists. Therefore, as the example of the theory of punctuated equilibria demonstrates, the Marxist influence on the
work of these biologists is often quite subtle. Although the biologists interviewed did
sometimes make analogies between their findings and some aspect of Marxist theory, often
their Marxism was more a methodological impulse than a fixed set of doctrines to be applied
to biology.

However, it is nevertheless possible to draw out some common themes—such as a shared
opposition to reductionism and an interest in dynamism and materiality—that, it is argued
here, are centrally important to the way dialectical biologists think about their work. Engaging
with these recurring themes has allowed me to reflect on what is distinctive about “dialectical”
as opposed to “mainstream” biology. But they are also relevant to the wider project of this
thesis of developing a more dialectical political ecology in the light of this survey of biological
thought.

Furthermore, there is a sense, when speaking to dialectical biologists and reading their work,
that the conventional ways of thinking in biology have taken knowledge so far. But, as there
are contradictions inherent in the way science is carried out, scientific knowledge has produced
limits to its own further development (Levins and Lewontin, 2007). For example, as will be
discussed further in the following chapter, evolution has come to be thought of as simply the
outcome of a relationship between an environment and its genes. The environment is treated as
applying a “pressure”, resulting in the selection of particular genes. Laland and others (2009),
a group of biologists influenced by Lewontin, argue that there are “conceptual barriers” to
further understanding in evolutionary theory. Evolutionary biology, they say, is founded on a
separation of causal factors whereby the ultimate causes driving the evolution of a species (ie
natural selection) are given priority over proximal causes. Other processes such as the way
species themselves modify their environments have been sidelined in biological theory. This is
hindering not just theories of evolution but the integration of evolutionary biology with
different branches of thought such as ecology, developmental biology and the “human
sciences” (Laland et al, 2009).

This sense that a reductionist way of thinking about science has created its own internal limits
to understanding was familiar to Engels. In 1880 he was already arguing that:

The analysis of nature into its individual parts, the grouping of the
different natural processes and objects in definite classes, the study of the
internal anatomy of organised bodies in their manifold forms—these were
the fundamental conditions of the gigantic strides in our knowledge of
nature that have been made during the last 400 years. But this method of
work has also left us as a legacy the habit of observing natural objects and
processes in isolation, apart from their connection with the vast whole; of
observing them in repose, not in motion; as constraints, not as essentially variables; in their death, not in their life.

For Engels, this way of thinking “cannot see the wood for the trees” (Engels, 1970 [1880]).

Critics of dialectical thought have sometimes argued that dialectics is a philosophy of external relations predicated on a binary opposition between society and nature (eg Whatmore, 1999, p25). However, this interpretation would not be familiar to Levins and Lewontin, for whom their method is founded on an antipathy towards binary oppositions including the conceptual treatment of humanity as alienated from the rest of nature (Levins and Lewontin, 2007, p14). Critics have also argued that dialectics does not pay sufficient attention to the agency or materiality of non-human life, concerns associated with more recent new/vital materialist trends in geography and political thought. However, this chapter has demonstrated that attention to materiality is actually centrally important to the conception of evolution developed by the dialectical biologists. The following chapter will continue to address these criticisms, explaining how dialectical biologists and their followers have addressed the issue of non-human agency. It will further show how environmental social scientists have started to utilise the work of Levins, Lewontin and others and will start to address the implications of their thought for political ecology in the Anthropocene.
Chapter 6: Constructed niches and novel ecosystems

The previous chapter put the dialectical biologists in context by describing the political movement that many of them were associated with, Science for the People. The chapter argued that these scientists adopted a sophisticated interpretation of scientific practice that recognised the contradiction inherent in making truth claims while also denying that science is neutral or that scientists are endowed with unmediated access to a stable and fixed nature. The chapter concluded by discussing some of the key contributions dialectical thought has made to biology. Central to this interpretation of dialectics is that elements thought to be distinct are seen through the dialectical lens as inseparable. It is a way of thinking that opposes the type of reductionism that considers parts as ontologically prior to wholes (Levins and Lewontin, 1985). Crucially, the things of the world are not essentially static and are changed when a force encounters them from without; dynamism is an inevitable and inescapable feature of the biological world.

This chapter builds on this insight with a discussion of one of dialectical biology’s major contributions, the proposal that living organisms (be they humans, other animals, viruses, fungi, plants, etc) play an active role in constructing their environments (Levins and Lewontin 1985; 2007; Lewontin 1982). This proposal, associated with Richard Lewontin in particular, has, since he first wrote about these issues, continued to gather enthusiastic advocates among biologists in the form of the theory of niche construction: “the process of organism-driven environmental modification” (Odling-Smee, Laland and Feldman, 2003). For John Vandermeer, an ecologist and member of SfP, niche construction continues Lewontin’s project of understanding the “dialectical” relationship of organism and environment (Vandermeer, 2004).

As will be explained in this chapter, social scientists concerned with the Anthropocene have found methodological and substantive contributions from dialectical biology relevant to their own work. Niche construction theory (NCT) in particular has the potential not only to challenge assumptions within biology but also to provoke a rethink within political ecology. This chapter therefore turns to issues more familiar to environmental geographers. Returning
to the theme of the Anthropocene with which this thesis began, it develops Richard Lewontin’s interpretation of dialectics in conversation with that of geographers such as Harvey and Swyngedouw to show how it might also be used to develop a non-dualist approach that complicates problematic binary interpretations of society and nature. This chapter further shows how dialectical biology has addressed, and might further inform, understandings of what happens in novel ecosystems, defined here as those where human agency is acknowledged as a significant influence. In particular it does this with the example of the work of Ivette Perfecto and John Vandermeer, agro-ecologists and activists who have worked with Richard Levins and, along with their colleagues, have built on his insights. The intention here is therefore to show how quite abstract debates in ecological and evolutionary theory have been applied to address more concrete concerns.

6.1: Organisms make their environments

One of the major contributions and most innovative lines of reasoning of the dialectical biologists is a centring of the organism and its actions within biological enquiry (Levins and Lewontin, 1985, Rose, 1997). As Lewontin points out in his important 1982 essay “organism and environment”, biologists have generally viewed organisms as passively responding to forces beyond their control (Lewontin, 1982). In this work, Lewontin challenges two metaphors that have become widely accepted and have channelled thinking in evolutionary biology. The “trial and error” model assumes, firstly, that it makes sense to refer to the external environment of an organism (of which more below) and secondly that this external environment effectively poses problems that an organism must solve by evolution (Brandon and Antonovics, 1996). As Darwin observed, a population of organisms will tend to vary in their characteristics and those with traits most suited to the environment will be more likely to survive and reproduce, therefore increasing their chances of passing on their genes (and associated phenotypes) to future generations. In this account, the specific features of the external environment that organisms encounter will act on that population and “select” certain individuals for survival. This leads over time to particular genes becoming common in the population by a trial and error process whereby variation offers up different phenotypes that may or may not be successful in being selected for. It is important to note that, in this analogy, pressures originating from outside the organism shape evolution (Levins and Lewontin, 1985, Royle, 2014). Therefore, this classic model of natural selection is classed as “externalist” (Godfrey-Smith, 1996). Or, in other words it is assumed that organisms must fit into a pre-

46 Strictly speaking, a novel ecosystem is established by humans but does not require continued human influence for its maintenance (see Hobbs et al, 2006). The term is used more loosely here for systems where human activity plays the predominant role in creating and/or maintaining the ecosystem.
established template represented by their environment (Laland, Odling-Smee, and Feldman, 2004).

Lewontin’s converse analogy is more associated with developmental biology—it is the idea of an organism developing throughout its lifetime on a predetermined path laid out for it by its genes or “unfolding” according to a particular plan. This metaphor, like that of trial and error, sees the organism as responding to forces outside of its control, although in this case those forces are internal to the organism’s body, arising from its genes and driving its development (Lewontin, 1982). Both of these analogies originated in the 19th century and are still common sense today.

Biology has therefore developed by imposing a separation between processes of heredity of genes and development of organisms on the one hand and the relationship between organism and environment on the other. As explained in chapter two, Lysenko erased this distinction entirely by supposing—wrongly—that individual organisms can freely assimilate aspects of their environment and pass down the influence of the environment directly to their offspring. Evolutionary biologists, have, in response to this, often been quite strict in delineating heredity from environmental influence. They have argued strongly that environments can only select the individuals within a population with the most beneficial genetic make-up rather than directly influencing an organism’s genes.

However, for Levins and Lewontin (1985), although the analogies developed by biologists are not wrong as such, their explanatory power has reached limits. As discussed in the previous chapter, metaphors are essential to biological thought as a way of formulating an understanding of complex systems (and explaining them to others), but metaphors also produce their own limits to understanding. Like Laland and others (2009) referred to at the end of the previous chapter, Levins and Lewontin argue that there are conceptual barriers to further understanding in biology. Both of the metaphors Lewontin draws our attention to suggest that organisms passively respond to external forces, whether originating in their environment or in their own genes; both treat the organism as an object of evolution, or (in a striking metaphor) as a receptacle in which the environment and genes interact. This has led to the organism itself becoming “in a curious way” irrelevant to evolutionists (Levins and Lewontin, 1985, see also Clark and York, 2005b).

By contrast, Levins and Lewontin argue that the organism ought also to be seen as a subject in evolutionary processes (Levins and Lewontin, 1985, pp87-89). This view is shared by Steven and Hilary Rose (2010), who note that “far from passively responding to a fixed environment, organisms…modify their environments”. Lewontin has even, strikingly, stated that organisms do not adapt to their environment. Instead they can be said to build or construct environments:
“organisms do not adapt to their environments; they construct them out of the bits and pieces of the external world” (Lewontin, 1983, p280); “they take bits and pieces of things that are out there already but to make them into an environment means to collect them together, to burrow in them, to chew them up, to do all kinds of things” (interview, 16 April 2014). Steven Rose has similarly used the term autopoiesis to refer to the ways in which organisms construct themselves (as “active players in their own destiny”), using their genes and environment as raw materials (Rose, 2012). Processes whereby living things alter their surroundings have been referred to as niche construction, and, as explained below, niche construction theory (or NCT) has gained some followers among ecologists and evolutionary biologists as well as some social scientists (see Odling-Smee, Laland and Feldman, 2003).

Lewontin’s approach, by treating the organism as playing an active role, extends the dialectical critique of reductionist or gene-centric science discussed in chapter five by turning its focus to the level of whole organisms. For Lewontin, the biological organism as much as the genes is a site of selection. In other words, although it is genes that are passed on to future generations, the process of selection cannot be understood without taking into account what happens at the level of the organism. Ultimately what the organism does—how it behaves and therefore how long it survives for, whether and how often it reproduces—is fundamentally important in deciding which genes are replicated. That organism cannot also be understood as distinct from its environment. For some, this provides a critique of gene-centric thinking that actually revisits Darwin’s original conception rather than going against it (Sinha, 2015). For Chris Sinha “the critique [of gene-centric biology] has always focused on the lack of attention to organism level dynamics” (interview, 19 August 2014).

6.1.1: Niche construction and ecology
Organisms act to influence their environment in various ways. Of course, one way in which a living thing might react to an environment that is (or becomes) inhospitable is simply by moving to a new place. But living things also literally modify or change their surroundings, for example, when a beaver changes the flow of a river by building a dam. Therefore, they cannot be thought of as simply responding to circumstances that they encounter. Furthermore, Levins and Lewontin refer to organisms’ ability to determine which aspects of their immediate surroundings are “relevant” to them. To use their example, a woodpecker might treat the bark of a tree as an aspect of its environment but ignore other objects around it such as the stones at the base of the tree. Other birds that use the stones to smash snail shells will treat the stones as a relevant aspect of their environment (Levins and Lewontin, 1985, p99). Therefore, as well as by physical modification, organisms also construct an environment in the sense of treating
some aspects of their immediate surroundings as part of their “environment” while ignoring others (Levins and Lewontin, 1985, pp98-99).

Ecologists make a distinction between niche and habitat which is useful here. The world in which organisms live is referred to as their niche. However, the niche only refers to a set of conditions that are relevant to that organism, as opposed to the habitat which encompasses the totality of the living and non-living elements of a particular place. The term niche is therefore used in a more relational sense “to describe how, rather than just where, an organism lives” (Begon, Townsend and Harper, 2006, p31; Preston, 2003, pp47-72). For example, the woodpeckers described by Levins and Lewontin might only be able to tolerate temperatures within a certain range, humidity within a certain range, a certain minimum amount of food, etc. This already implies that a niche does not exist without the organism that lives in it. If there was no such thing as a woodpecker, the habitat (the woodland) would still be there but it would make little sense to refer to the niche of such a creature. Furthermore, the niche of a woodpecker consists of factors that relate to each other as well as to the bird in complex ways (the insects the woodpecker eats also relate to the bark of the trees) so the niche represents a complex of interacting factors that cannot be easily fully described or accounted for.

Of course, those who point out that organisms construct their environments are making what seems an obvious point and, in a sense, NCT advocates are saying nothing new. It is well known that beavers change their immediate surroundings by building dams; that birds, ants and various other animals build nests and that plants change the composition of the soil (Odling-Smee, Laland and Feldman, 2003; Laland and Sterelny, 2006). Indeed, changing the composition of the external environment, even by taking in nutrients and expelling waste products, is fundamental to what all living things do (Levins and Lewontin, 2007, p33). However, these processes have often been neglected in ecological analysis. Biologists have found that niche construction is often omitted from mathematical models and that explicitly taking it into account in these models produces novel results (Feldman and Laland, 1996).

Non-humans can often have dramatic effects on their surroundings. For example, leafcutter ants, which grow (or farm) fungi in gardens on a substrate of fresh vegetation, can utilise the steady supply of food this gives them to build massive colonies, sometimes with millions of workers. These colonies have been known to destroy citrus plantations in Brazil; they can also contribute to the regrowth of rainforests as the soil they expel is easier for young plants to root in. So, the actions of the ants modify the environment for other species, having a destructive influence for the citrus plants and the humans in this example but enabling other organisms to thrive. It is important here to grasp the key point that NCT theorists are making, that for an ant hatching in the colony, the environment it will be exposed to throughout its life is itself the
product of the actions of its fellow ants (Odling-Smee, Laland and Feldman, 2003). This constructed environment is sometimes referred to as an ecological inheritance.

Interestingly, Lewontin noted the effects of niche construction long before concretising it into a theory. In order to carry out his work on the genetics of the fruit fly *Drosophila pseudoobscura* as a graduate student in the 1950s he kept fly larvae in the lab on a solid medium seeded with yeast. The larvae would burrow into the medium, increasing its surface area and therefore allowing more yeast to grow. The flies increased their own food supply by their actions. With an increasing population of flies, the amount of food available per individual, and consequently the likelihood of survival for each individual, would, at least up to a point, tend to increase rather than decrease as might be assumed (Lewontin, 1955 and personal communication). Lewontin referred to the ways in which the actions of the fly larvae *facilitate* the growth of the yeast: “The existence of an optimal density for larval survival, below which viability is lowered, seems a clear demonstration of a facilitation effect. If any resource is in short supply in the lowest densities, which is present in intermediate densities, this resource must be one which is supplied by the organisms themselves” (Lewontin, 1955, p36).

The implications of this for human population growth have not been lost on some biologists. Lewontin suggests that a certain minimum number of individuals is beneficial—even necessary—within any given population in order to construct a suitable niche (Vandermeer, 2008). This point applies to living things in general but, given the prevalence of concerns about human population, John Vandermeer has used the notion of a minimum necessary population to counter the assumption that “there are always too many people” (Vandermeer, 2012). However, with human environmental issues also no doubt in mind, Odling-Smee and others have argued that when organisms make their environment less conducive to their own survival, perhaps by causing damaging pollutants to build up, this could be referred to as niche destruction. The substantial effects human activity is having in the Anthropocene might, for these authors, then be viewed as niche destruction on a global scale (Odling-Smee, Laland and Feldman, 2003, p47).

Kevin Laland, one of the most prominent advocates of niche construction, explains further how it challenges the assumption that environments have a fixed carrying capacity (the number of individuals of a species an environment can accommodate). Laland has used niche construction to pursue interdisciplinary work including with economists. Here he touches on the relevance of this theory for the human sciences, of which more later:

> I think partly the inspiration for [working with economists] is a different way of thinking about environments found amongst ecologists and
economists. Ecologists tend to think about the environment as having a sort of fixed carrying capacity so populations will grow until they reach that carrying capacity and that’s how big the population will be and the carrying capacity reflects the properties of the external environment so it’s an exogenous property. Whereas economists—and of course if you’ve very much got humans in mind humans are champion niche constructors—economists tend to think of environments as being very much under endogenous control so it’s as if the carrying capacity depends on what you do (interview, 17 December 2015).

Indeed, these ideas have taken root in and influenced a range of disciplines. A paper in Nature proposes that considering cancer cells to be engaged in niche construction by modifying their immediate environment to make it more suitable for their own development could fundamentally change how we view (and treat) the disease. It refers to a shift in focus from viewing cancer purely in terms of the genetics of the cancer cells themselves towards acknowledging a “dynamic interplay” between cancerous cells and the cells around them (Barcellos-Hoff, Lyden and Wang, 2013).

6.1.2: A neglected process in evolution

This chapter has, so far, given examples of niche construction in ecology, a sub-discipline of biology concerned with the “interrelationships between living organisms and their physical environment” (Walker, 2005, p78). Ecologists tend to deal with effects over short timescales, perhaps studying a particular group of animals for a few generations or monitoring an event such as the introduction of a new species to an ecosystem. However, according to NCT, these widespread processes of environmental modification, as well as being of interest to ecologists, also represent a “neglected process” in evolutionary biology, concerned with changes to species taking place over much longer periods of time (Odling-Smee, Laland and Feldman, 2003), although this claim has been the subject of some debate. Erle Ellis, whose own background is in ecology, notes how niche construction thinking is only recently—in the last few years—gaining traction among biologists. For Ellis: “It is a very disruptive, powerful theory in ecology. It really changes the way you think about evolution and ecology and it provides a linkage between evolution and ecology” (interview, 23 August 2016).

According to its supporters, niche construction is not incidental to evolution but, on the contrary, represent a major force that had been somewhat overlooked in the past: “We weren’t following through and thinking about how that change in the environment then fed back to influence selection… So we tended to think of things in what you might think of as a
unidirectional causal way” (Kevin Laland, interview, 17 December 2015). The ability of organisms to construct a niche has often been thought of as a consequence of evolution; the result of thousands of generations of evolution. However, according to theories of niche construction, it is also a causal factor. Living things alter their own surroundings (and those of other organisms around them) and thereby expose their own offspring to these constructed environments—as in the case of the leafcutter ants discussed above. In this way an organism’s actions can be said to drive the evolutionary process by influencing the selection pressures on its own offspring. Therefore, niche construction represents a second route through which organisms pass on information to their descendants, by environmental modification as well as in the form of genes passed from parent to offspring via reproduction. Niche construction, for some of its advocates, is as general a process within evolution as natural selection, and as significant. But, this second route “has been almost completely ignored in evolutionary biology” (Brandon and Antonovics, 1996, p176) in favour of a standard evolutionary theory (SET) that tends to play down the active role of organisms (Odling-Smee, Laland and Feldman, 2003; Laland and Sterelny, 2006; Royle, 2017).

The example of the way earthworms modify their environment is often used to demonstrate the principle. Worms construct their environment by their digging behaviour, aerating the soil, mixing it with organic matter and facilitating plant growth. This means that, like many other species, they live in and adapt to an environment that has been substantially altered by their own ancestors (Laland, Odling-Smee and Feldman, 2004). But furthermore, because earthworms have modified the water levels in their surroundings, they have been able to maintain many of the traits of their aquatic relatives including external kidney-like organs (nephridia) not generally found in land animals. In an aquatic environment the nephridia serve to remove excess water from the animal’s body; in worms the same organs extract moisture from the soil (Odling-Smee, Laland and Feldman, 2003).

Niche construction theorists argue that the presence of earthworms—essentially aquatic animals—on land cannot be adequately explained by the SET as these animals simply cannot survive in their environment without making substantial changes to it (Odling-Smee, Laland and Feldman, 2003, pp374-376). The worm hasn’t adapted itself to become more suited to its terrestrial environment. Instead, earthworms have constructed a niche that suits their physiology. According to the classical interpretation of natural selection, adaptation results in a good “fit” between phenotype and environment. For example, in a population of worms living in soil they will evolve to be well adapted to moving through soil. In NCT, by contrast, a “dynamic interaction” between niche construction and natural selection produces this organism-environment match (Odling-Smee et al, 2013). NCT additionally draws attention to the way digging behaviour affects traits of the worm not directly related to digging such as the
retention of nephridia. The worms’ digging activity also affects other organisms, for example plants and soil-dwelling microbes.

But the idea that the actions of organisms today can influence their offspring, and especially that they might drive evolution in a particular direction, has been controversial within evolutionary biology. This isn’t helped by the fact that niche construction is sometimes described as “Lamarckian”, even by sympathetic commentators. For example, Stallins says: “niche construction is Lamarckian in that organisms have the propensity to pass [their relationship with their environment] on generationally” (Stallins, 2012, p433). However, Laland and his colleagues have repeatedly referred to it as a “non-Lamarckian” mechanism of inheritance (see Laland et al, 2009). Lamarckism is often defined as the inheritance of characteristics developed by an individual throughout its lifetime and passed to its offspring and therefore has some similarities with Lysenko’s views. There has been some debate as to whether this characterisation unduly focuses on just one aspect of Jean-Baptiste Lamarck’s wide-ranging thought, and indeed whether recent findings in the field of epigenetics have proved him partially correct (Parrington, 2015, chapter 9). However, as niche construction doesn’t involve the direct transmission of acquired characteristics from parent to offspring via the genes the term “Lamarckian” is best dispensed with here.

It should be noted also that niche construction does not make the theory of natural selection redundant. Indeed, NCT can complement Darwinian natural selection. Take the example of the African elephant. Clearly, elephants are adapted to living in hot, dry, grasslands: large ears help them keep cool; they can survive for long periods without water; their trumpeting calls carry well across the savannah. These adaptations can be interpreted by natural selection—the most adapted animals are best able to survive and pass on their genes. However, the grassland to which they are adapted is to a large extent created by past generations of elephants, known to prevent forest succession by destroying small trees (Laws, 1970). Therefore elephants are increasing their exposure to grassland environments and facilitating natural selection. In other words, NCT demonstrates how an organism being a subject in evolution and simultaneously an object of what it has created can act to increase the selection pressures to which it is exposed. This view recognises that, although the variation within a population of individuals is random, the environmental influence on evolution is anything but random (Clark, Foster and York, 2007, p537), natural selection drives evolution in a particular direction—ie towards a better fit between organism and environment—and this non-random influence might also be created by the actions of the organism itself.

Due to this emphasis on processes that are not due to chance, New Scientist magazine suggested in a 2013 feature article that the idea of niche construction was “heretical” and likely to “make steam rise from an evolutionary biologist’s ears” as it suggests that something other
than changes in the frequencies of particular genes can act as a driving force of evolution (Holmes, 2013). Richard Dawkins, a popular science writer and niche construction sceptic, declined the magazine's request for comment. In the past Dawkins has described the reasoning behind the theory as “pernicious” (Dawkins, 2004).

The following year, in October 2014, the scientific journal Nature ran a debate between two groups of biologists on the subject of whether evolutionary biology needs an urgent rethink (Laland et al, 2014). Some, including NCT supporter Kevin Laland argued in favour of a shift in the central tenets of evolutionary theory. Indeed, niche construction is just one element of the call for an extended evolutionary synthesis mentioned in the previous chapter (Odling-Smee, Feldman and Laland, 2003). Advocates of an extended synthesis hope to overcome some of the limitations of standard evolutionary theory (SET) and to integrate work in evolutionary theory with that in other fields such as developmental biology, ecology and even the social sciences. For example, supporters of this extended synthesis also wish to integrate evolutionary theory with a greater understanding of new findings in epigenetics (Laland et al, 2014). Laland and others also propose that theory should incorporate an understanding of the processes by which organisms develop throughout their lifetimes as well as the complex ways in which they interact with their environments. Evo-devo which, as discussed in the previous chapter, integrates insights from developmental biology into an understanding of evolution, is therefore also an aspect of the extended synthesis.

Laland’s interlocutors, who say that “all is well” with evolutionary theory, agree that biology should deal with organism-environment relationships. However, they claim biology already does this. They say that the discipline has already been carrying out work on how organisms change their immediate surroundings “for well over a century” (Laland et al, 2014, p163). As Vandermeer puts it, the response was “we have been thinking about these things all along and there is nothing to do here”; for Vandermeer, this is merely proof that: “Most evolutionary biologists kind of accept the dialectical approach even though they might not admit it” (interview, 8 April 2015).

But Dawkins does have real differences with the niche construction theorists. He proposes an alternative model—the extended phenotype (Dawkins, 2004). In addition to the aspects of an organism’s physiology coded for by its genes (and therefore considered part of the phenotype), Dawkins suggests that genes also express themselves in an “extended phenotype” outside the

47 It has also been argued elsewhere that niche construction makes a limited difference to biologists’ findings although its followers refute this claim (Laland and Sterelny, 2006).

48 Apparently, some biologists have, understandably, felt that they ought to emphasise natural selection and play down other processes that may be at work in evolution in order to present a united front against anti-evolutionists (Laland et al, 2014).
organism’s body. The dam a beaver produces—under the instruction of its genes—is, for Dawkins, as much a part of its phenotype as its teeth and fur. There is essentially no distinction between what is inside the body and what is without; no process by which the environment can influence the body. It should be expected that Dawkins takes this view, it is consistent with his famous assertion that the phenotype, including the body itself, should be considered as essentially a means for genes to replicate themselves. He considers the organism’s body as a niche for its genes “we are survival machines—robot vehicles blindly programmed to preserve the selfish molecules known as genes” (Dawkins, 1976, p.ix).

However, niche construction theorists are dissatisfied with Dawkins’ extended phenotype proposal. Dawkins accepts that the consequences of niche constructing activities could act back on the organism and affect its evolution, for example the beaver’s ability to build a dam results in a “fitness payoff” benefiting the genes involved in dam building. However, the same could be said of other elements of the beaver’s phenotype such as its fur. In niche construction the environment acts back on an organism affecting other aspects of its genetic make-up. This makes it more than just an extension of its phenotype (Odling-Smee, Laland and Feldman, 2003, pp131-132). For niche construction to make sense, the environment must also be able to act on the organism and its descendants, causing natural selection, as well as just being a consequence of the organism’s genes. The constructed environment cannot simply be dissolved into an extension of the organism as Dawkins implies.

This chapter has so far demonstrated how the theory that organisms actively construct their environments has challenged existing thinking in ecology and evolutionary theory. It will go on to address the implications of this for what we mean by “environment”. But first, there are two questions that remain to be answered here: whether niche construction is a theory of non-human agency and whether it is a Marxist theory.

6.1.3: A theory of non-human agency?
As explained in chapter three, complicating claims that only humans possess agency has been a central contribution of new materialist thinking and of much of recent animal geography. It is also an aspect of new materialism that some historical materialist thinkers such as Malm have criticised (see Malm, 2018). Therefore, it is interesting to note that niche construction theorists have sometimes used the term “agency”, pointing to an interpretation of dialectics that does account for non-human agency. Kevin Laland at the University of St Andrews and his colleagues claim on their website that organisms “exhibit active agency”, are “co-directors of their own evolution” and “drive environmental change” (Odling-Smee, Laland and Feldman, 2018). Strikingly, they have also referred to the way in which organisms modify environments
as “repeatable”, “directional” and “systematic”, even suggesting that such niche construction has a “purpose” (Laland et al, 2014, p162). This is not to say that non-humans act consciously in pursuit of a particular goal, but they do act in a particular way under the influence of their genes (a distinction between conscious, intentional action and agency in general that new materialist thinkers also seem largely to accept). NCT does imply that living things display behaviour that is “directed” in the sense that there may be positive feedback loops at work that channel action in a particular direction. For example, in Lewontin’s fly larvae example (Lewontin, 1955) the actions of the digging animals meant that more food was available, therefore increasing the population and in turn meaning that more food production could take place.

Not all of niche construction theory’s advocates describe themselves as Marxists and the idea of organisms constructing their environments has spread far beyond the fairly select group of dialectical biologists. However, for some it is a major example, perhaps the most compelling, of dialectical thinking in biology. Indeed, for Lewontin niche construction is “the best example I can think of of a dialectical approach to biology” (interview, 16 April 2014). The Marxist writer Jason Moore has also referred to the centrality of the dialectical biologists’ insights into the way organisms and environments are mutually constituted to their worldview. Moore sees this approach as going against the “basic unit” approach that adds together society and nature: “Yeah that’s right at the centre, if you boil it down to the simplest arguments: species make environments and environments make species there’s a double internality there… That seems to me extraordinarily powerful because it defies the basic unit approach and the basic unit approach is still the approach of nearly all Marxists” (interview, 3 November 2016).

Lewontin’s work on the dialectical relationship between environment and organism was raised, unprompted, in several of the interviews for this thesis, which, as well as its implications for the vexed issue of non-human agency, explains the amount of attention given here to this particular idea.

For some of the biologists interviewed, the idea that organisms make their environments recalls Marx’s famous saying that people “make their own history, but they do not make it as they please” (Marx, 1852). And Lewontin is explicit about the analogy between niche construction and the view that society can change, explaining how social structures and human action are mutually transformative:

The way organisms make their own environment—that’s a dialectical principle. That’s one of the most important political principles there is, that people don’t just experience classes, they don’t just experience society, they are in a constant process of making and transforming society and that’s the basis on which dialecticians call for revolution. They claim
that revolution will work because they claim everything about the way we live is a product of human behaviour which creates structures and those structures then reinforce that behaviour because we accept them as, you know, “out there” that you can’t do anything about—so let’s make a revolution (interview, 16 April 2014).

His references to the organism as subject and object of evolution also echo the wording of Lukács, for whom the proletariat have the potential to act as “simultaneously the subject and object of the socio-historical process” (1971, p19). This point is of particular interest here. As discussed in chapter two, Lukács was (at least in his early writings) reluctant to apply dialectical thinking to processes in “nature”. The dialectical biologists’ work suggests, however, that he was mistaken to see the subject-object interaction as “absent from our knowledge of nature” and to refer exclusively to conscious human actors when describing them in these terms (Lukács, 1971, p24). Although many would agree with Lukács that workers in a capitalist society are unique in contributing surplus value by their actions, as Burkett (2013) concurs, Levins and Lewontin’s work has found subjective processes in the biological world as well as in the social.

But niche construction theory raises a problem: its advocates deny that the environment is external to the organism, but does this mean that differences between organism and environment are dissolved into nothing more than a complex of relations? And if so, how can an organism also act on the environment to transform it? This chapter has so far referred to organisms as “making their environment” and suggested that the theory has implications for thinking about the human relationship with the environment in the sense of “environmental” politics in the Anthropocene. But the definition of “environment” is the subject of some debate: living things can be said to relate to the environment, produce an environment, construct an environment or act through their environment. Some have even argued that there is no such thing as the environment. This issue is relevant to the debates between Marxists discussed in chapter two. Whether dialectics is purely a theory of internal relations or whether there is also a need to take account of a reciprocal relationship between society and nature is one of the key points of difference between world-ecologists and metabolic rift theorists. Therefore, the following section discusses what insights dialectical biologists can provide for discussions of this thorny issue.

6.2: On whether “the environment” exists

Biologist Matthew Cobb, who is sympathetic to dialectics but critical of Lewontin (interview, 22 October 2015) asks the question, is there an “environment” on Mars? As he points out, for
somebody studying atmospherics, there is something worth studying on Mars, elements of what might be called an environment. In Darwinian natural selection, it seems that there is such a thing as an environment and that it exists prior to the organism that lives within it. Living things are tacitly assumed to exist within particular limits that circumscribe what is a suitable environment—the implication being that if something encounters conditions to which it cannot adapt it will not survive. In this account, the arrow of causation goes in one direction, from environment to organism.

However, for Levins and Lewontin, their dialectical approach, as with the various examples from dialectical biology discussed in the previous chapter, is founded on a rejection of such a strict separation of causes (Levins and Lewontin, 2007). As explained above, niche construction theorists remind us that a niche can also be said not to exist without the associated organism. NCT poses an explicit challenge to the idea of a niche as something existing without the organism that it must adapt to: “a hole in the wall and you come and sit in it” (interview, 16 April 2014). The notion of a constructed niche is clearly in contrast to Darwin’s more conservative metaphor of the niche being something like a job role in the way that factory workers each have their own role to play in the workplace.

It would be possible nevertheless to consider the organism-environment relationship as one in which there is reciprocal causation but where two separate entities influence each other in a back and forth relationship. Sometimes the metaphor of billiard balls colliding is invoked to describe such a relationship where one entity impacts on another from the outside (See Friedman and Rossi, 2011 for example). This notion of discrete entities relating to each other recalls what Ollman refers to as a philosophy of external relations (see chapter two). However, building such a model is clearly also far from the intentions of the dialectical biologists; it is precisely the notion that there is such a distinction to be drawn between organism and environment that is challenged by their thought (Vandermeer, 2008). Rather, by stressing the ways in which organism and environment construct each other over time, the dialectical approach reminds us that neither can exist independently of the other. So it emphasises a relationship between organism and environment while at the same time being inherently critical of dualist understandings which begin with the notion that they are two separate entities that must then come to relate to each other.

Levins and Lewontin have sometimes spoken in terms of reciprocal relationships and feedback between organism and environment, for example when they say: “Changes within the organism alter the external environment, which in effect then feeds back into the development and metabolism of the organism itself” (2007, p83). And some niche construction theorists treat organism and environment as “coevolving” or mutually influencing each other (Odling-
Smee, Laland and Feldman, 2003, p2). Here these biologists state that they are applying “a mix of externalist and constructivist explanations” (p373).

For Clark and York (2005a), niche construction theory implies that an organism exists in a dialectical relationship with an environment and similarly a human society can be thought of as in such a dialectical relationship. These authors do sometimes slip into binaries. For example, they refer to a “dialectical interchange between the environment and the organism” (Clark and York, 2005b, p328, emphasis added) and “the interaction between humans and the environment” (p332). However, they also stress that this is a dynamic relationship of mutual transformation rather than a simple case of reciprocal interaction between internal and external.

Similarly, John Vandermeer emphasises that a dialectical approach suggests a difference between organism and environment, a differentiated rather than an undifferentiated unity. He also refers to a contradiction between organism and environment that is ongoing and dynamic, rather than being “resolved”, for example by referring to the whole as an organism-environment complex:

I think the real dialectical approach recognises that there is some kind of difference between organism and environment but the fact they are dialectically related means that organism causes environment and that environment causes the organism, that there is a mutual interpenetration of the two ideas. And it’s not just a vague idea of a complex, of an environmental-organism complex but that rather there is a dynamical process whereby environment is created by organism and organism is created by environment. It seems to me that’s the proper way to look at it…. They are relating to one another in a very dynamic and synthetic fashion… Constructing each other is a good way to put it (interview, 8 April 2015).

This view might not satisfy those who see “dialectically related” as retaining some dualist implications. However, in Vandermeer’s interpretation there is no possibility that environment and organism exist prior to one another as they are mutually creative. Also, importantly, he refers to a dynamic process, one that develops and changes through time.

However, elsewhere Levins and Lewontin have more radically rejected the existence of the “environment” entirely, criticising any kind of prior distinction between organism and niche and adopting something closer to a philosophy of internal relations. For example, they state that: “one cannot make a sensible environmental politics with the slogan ‘save the environment’ because, first, ‘the’ environment does not exist, and second, because every
species, not only the human species, is at every moment constructing and destroying the world it inhabits” (Levins and Lewontin, 2007, p34). (Note here that the biologists are switching the focus of their critique from the specifics of evolutionary biology to making statements about humans and “environmental” politics).

Lewontin’s view that “the environment does not exist” has also been adopted by some political ecologists. For example, Alex Loftus (2012, p.xiv) echoes this statement, declaring that “there’s no such thing as nature”. This is one aspect of dialectical biology that social theorists, including Maria Kaika (2005, p23) and Erik Swyngedouw (2014; 2015) have found particularly interesting. They have referred to Levins and Lewontin in order to question the adoption of “the environment” as a stable or predictable object of analysis. For example, in a recent discussion of politicised nature in the Anthropocene, Swyngedouw notes that, for Levins and Lewontin:

The biological world is relationally constituted through contingent, historically produced, infinitely variable forms in which each part (human and non-human, organic and non-organic) is intrinsically connected to wider relations comprising the whole… Levins and Lewontin thus reject a simplistic, reductionist, teleological and ultimately homogenising view of nature—arguing that there [are] various different historical natures, relations and environments subject to continuous, occasionally dramatic and rarely (fully) predictable changes… There is no nature that requires salvation in the name of either nature itself or humanity (Swyngedouw, 2015, p135).

Here Swyngedouw agrees that the dialectical biologists offer a picture of nature as “relationally constituted” and that their outlook stresses the dynamism and contingency of natural processes. He also importantly shows how, in their work, there are multiple possible environments, rather than “the environment”. Natures are historical and therefore cannot be relied on to provide the basis for a natural state of things. Swyngedouw does not deny the physical existence of carbon dioxide molecules, or owls or earthworms—“this is not to ignore the real of natures” (Swyngedouw, 2015, p141). However, Levins and Lewontin’s work is used here to put the case for a repoliticisation of nature by recognising that it cannot be extracted from the relations including the political relations that constitute it. Richard Levins has also expressed something similar to this interpretation. He has stated, in terms quite similar to notions of the “production” of nature, that the key thing to know about geography is that every type of society creates a different environment and that organisms construct their environments at different spatial scales (personal communication, April 2014). Levins has also referred critically to the assumption that “environments” exist in a state of balance or harmony.
when not influenced by humans, an aspect of the “idealism” of early environmentalism (Levins, 2007).

It could be argued that real biological systems are too complex and involve too many actors to be adequately accounted for by reference to two factors—organism and environment. This can be accused of reducing analysis to the interactions of two types when, in reality, ecological systems involve multiple interacting agents and processes including humans, animals, plants, microbes, technologies and geological processes. This is partly an issue of abstraction. As noted in the previous chapter, like any scientists, Levins and Lewontin must employ models that describe only particular aspects of a wider system. But they differ from mainstream biologists in that they invoke Marx (and Ollman) when describing their method of abstraction, a way of momentarily bringing one dynamic into view in order to examine it while recognising that “the truth is the whole” (Levins and Lewontin, 2007, p186).

However, there also needs to be a justification for the choice of abstraction. In volume one of *Capital*, Marx started with the commodity form and uncovered the relations of value that manifest in commodities (Marx, 1976). For the dialectical biologists, their choice of organism and environment can be viewed as an abstraction that brings different elements into view at any one point. For Vandermeer, simply stating that systems are built of multiple interacting factors is more reminiscent of systems biology than dialectics. When asked about the differences between the two, he argued that systems biology is merely another form of reductionism as it takes all the elements in a system and seeks to establish every possible connection between those elements. The dialectical approach, by contrast, “is one that uses a modelling framework which asks which things are key to the system and which things are interacting with one another in a profound or meaningful way then takes a synthesis of these and takes a new thesis and antithesis out of the synthesis and goes in a stepwise fashion to try to understand the system” (interview with John Vandermeer, 8 April 2015).

Critics of dialectical biology might also contend that new thinking in the life sciences treats organism and environment as themselves so entwined that it is no longer justifiable to use organism and environment as points of reference. For example, Gilbert, Sapp and Tauber (2012) say that, once the role of the microbiome is acknowledged, animals can no longer be thought of as individuals, a point that has been seized on by some new materialist thinkers among others (see chapter three). Here, it seems that Levins and Lewontin, if we interpret their work as being built on a philosophy of internal relations, would have little problem with these insights. For example, they also recognise that organisms are effectively “environments” for the other organisms that live on or in them, so what is an “environment” is defined relationally rather than something that just exists.
In summary, the view of organism and environment elaborated by Levins and Lewontin suggests a seemingly contradictory situation whereby an organism is inseparable from the environment and cannot be understood without reference to it, but also one where organism and environment act on and relate to each other. As explained in chapter two, Marx and Engels, in some of their writing on humans and the environment, similarly suggested that they thought of humans as part of nature while simultaneously being able to establish a relationship with external nature through acting on it (by exercising labour power in their terms). Writing in *The German Ideology* they stated that: “The first premise of all human history is, of course, the existence of living human individuals” and in *Capital* Marx refers to the way in which the actions of humans change external nature and simultaneously change their own nature (1976, chapter 7). Niche construction theory’s emphasis on dynamic processes, reciprocal causation, development of organism and environment through time and the ability to act on an environment and change it, all therefore have echoes in Marxist philosophy dating back to its founders’ own thinking. As the following section demonstrates, the approach to thinking about organism and environment has the potential to provoke a rethink in political ecology and human geography more generally.49

### 6.3: Niche construction and human geography

According to Richard Levins, niche construction has implications for thinking about space and scale. He has argued that, not only do organisms make their own environments, they also construct them at different scales. A mouse will be able to travel around over larger areas than an ant and therefore find processes operating at larger spatial scales relevant. Very small organisms such as bacteria are influenced by processes such as Brownian motion that are irrelevant to larger organisms (Levins and Lewontin, 1985, p104). This reminder that it is not just humans that construct scale has implications for the debates within geography about whether the concept of scale is necessary (see Marston, Jones and Woodward, 2005).

For Stallins, the notion of scale, however it is conceived, cannot be done away with as all living things participate in producing space and scale by their niche constructing activities (Stallins, 2012). Furthermore, Stallins shows how niche construction can mean that organisms (human and otherwise) even out fluctuations in environmental conditions in order to survive. For example, the digging worms mentioned earlier are producing a stable, predictable environment with stabilising consequences for their physiology rather than driving evolution in a particular direction. More generally Stallins argues that new ideas about organism-

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49 Physical geographers have also referred to niche construction. For example, Corenblit and others refer to it as a feedback mechanism whereby evolutionary processes and the construction of landforms mutually influence each other (Corenblit et al, 2011).
environment interactions offer the opportunity to fuse the biological with the geographical, proposing that engaging with current biological thought need not lead to the “crude reductionism or inflexible causal determinism” associated with earlier environmental determinist attempts to bring ideas from the natural sciences into geography (Stallins, 2012, p434). He argues that what is deterministic and what is contingent cannot easily be segregated when organismal agency is taken into account. Although he does not mention the roots of niche construction in dialectical thought, dialectics offers one powerful methodological framework for understanding how biological systems can exhibit both deterministic and contingent attributes (see Clark, Foster and York, 2007).

In a way analogous to how Marx and Engels criticised both idealism and mechanistic variants of materialism, dialectical biologists such as Gould have also referred to contingent as well as deterministic processes as occurring in evolution. As Clark, Foster and York suppose, this emphasis on contingency in Gould’s work comes about partly as society and nature are themselves inseparable, so contingent and open processes are common to both social and natural history. They also note the influence of 1930s Marxist thinkers in biology:

Marx’s dialectics of nature and society continues to serve as a powerful base for a critique… It includes a commitment to a materialist conception of natural and social history—and thus to the interaction of necessity and contingency. From this tradition, which has influenced noted scientists, such as JBS Haldane, JD Bernal, Hyman Levy and Lancelot Hogben in the 1930s and 1940s and Stephen Jay Gould, Richard Lewontin, Richard Levins, amongst numerous others in recent years, we can gain insights into the dynamic development and interaction of society and nature. Stephen Jay Gould noted that it was from the social sciences and humanities that he came to learn the importance of contingency: “The more we learn about complex systems,” writes Gould, “the less we can sustain a belief that classical reductionism might work, and the more we must suspect that emergence and contingency will enter in ever more important ways as we mount the scale of complexity in nature’s material reality”. While this statement is a critique of hyper-reductionism within science, it also serves as a reminder that the future is contingent and open (Clark, Foster and York, 2007, p538).

Some of the implications of dialectical biology for political ecology have been suggested by Brett Clark and Richard York (2005a and 2005b), two colleagues of John Bellamy Foster. They propose using the concept of a dialectics of nature rooted in Levins and Lewontin’s work to argue against two (common sense) understandings of environmental issues—economism
and deep green thinking. The authors equate economism with a mechanistic materialist philosophy—it supposes that society acts like a machine that can be made more environmentally friendly by including “nature” as an explicit input that merely needs to be correctly measured and accounted for, for example by valuing nature as a provider of ecosystem services. The faulty machine of capitalism can be fixed by making some slight adjustments such as by using greener technology. By contrast, deep green thinking (equated with philosophical idealism) sees nature as an autonomous sphere with its own needs that are fundamentally opposed to the demands of industrial, Western human societies. This way of thinking (ahistorically) assumes a natural state of balance or harmony which is upset by human action.

Although these perspectives might seem to be polar opposites, both ways of thinking treat society and nature as separate and incompatible. Both tend towards seeing “nature” as external to human society, whether as a source of inputs or as a balanced and harmonious realm that humans disrupt (Clark and York, 2005a and 2005b; Castree, 2000, p11). Clark and York argue that, by contrast, the dialectical biology approach avoids both mechanical materialism and idealism, providing a distinctive approach whereby the society-nature relationship as a dynamic one involving society and nature mutually acting to transform each other.

Norgaard and Kallis (2011) also refer to Levins and Lewontin’s work. Noting that “dynamic interactions between human and environmental systems are at the core of the discipline” of geography, they call for a greater recognition of what they call co-evolutionary dynamics, in other words situations where an evolving system transforms another but also reacts to this transformation. For Kallis, like Clark and York, such an approach avoids either social or environmental determinism, with the former represented by mainstream technocratic approaches to environmental problems where one input can simply be substituted for another and the latter by assertions of a “limits to growth”. Instead, coevolution involves recognising that cultural processes such as technologies, practices and knowledges transform environments but are also transformed by them. Additional complexity is added to this analysis by acknowledging, for example, the importance of power relations in “structuring environmental change” and the role of ideology in framing understandings of environmental problems (Norgaard and Kallis, 2011, p293). For these authors, this approach implies more than just a dyad where two things relate to each other. They refer to evolution in the biological sense in that they are interested in examples where there is some kind of selection mechanism at work. For example, if (hypothetically) a range of different pesticides are on offer to deal with an insect pest, the most effective might be selected for by the people using it but this might also influence the (biological) evolution of the pest species and in turn influence the pest control regime. In a discussion of the Anthropocene, Swyngedouw refers to Norgaard’s work as well
as Neil Smith’s production of nature thesis to emphasise the apparently changed role of humans as subjects that produce environments as well as objects of nature (Swyngedouw, 2015, p132).

Drawing in particular on Levins and Lewontin’s critique of assumptions about adaptation in evolution, political ecologist Michael Watts (2015) has also recently referred to their ideas. As Watts explains, the concept of adaptation has often framed work within cultural ecology on human societies and how they relate to their environments. For example, Roy Rappaport’s 1960s work on ritual pig slaughter among Papua New Guinea’s Tsembaga Maring showed how rituals helped people adapt to environmental fluctuations by maintaining a certain pig population (see Watts, 2015, pp23-26). Cultural ecology treated human populations as analogous to the populations of other species referred to by ecologists. It borrowed some of its concepts from biology, including the term “niche”, the notion of a carrying capacity (which carries with it the assumption that environments have a fixed capacity to sustain a certain population) and the concept of homeostasis, in other words the idea that populations act in order to preserve or maintain an existing state.

Adaptation, according to Watts’ analysis of cultural ecology, implied an end state, that of being adapted. It drew on Darwin’s ideas and on Darwin’s own Malthusian influence. But this work appeared increasingly problematic when political ecology started to focus on the transformations of global capital. For Watts, the “most troublesome” aspect of some of the early work was that it downplayed human agency and did not see it in social terms (2015, p22); in Watts’ words it saw regulation of responses to the environment as taking place “behind the backs of the actors” (p31). However, by referring to Levins and Lewontin’s work, Watts shows that adaptation-centred ideas are not the only ideas within biology. It is also possible to critique the mechanistic assumption of a fixed carrying capacity—as discussed above, niche construction biologist Kevin Laland has also done this—and to point out that organisms do not simply adapt to their environments. Work within radical biology also showed how evolution is not always adaptive, producing outcomes by chance, for example, as well as in response to selective pressure.

Watts comments that the adaptation paradigm has re-emerged in political ecology with the concept of resilience. He says that as environmental research has increasingly focused on climate change as an imminent global threat, the language of adaptation has again become ubiquitous: adaptation “has emerged as the lodestar of public and developmental policy”.

Furthermore, “the focus is on proximate rather than structural processes regarding adaptation in social systems, and on passive, reactive, or anticipatory adjustments” (Watts, 2015, p20). Watts argues that the hegemony that adaptation has gained in policy circles imposes limits to the range of responses to climate change on offer.
Biologists have drawn attention to the ways in which the activities of different organisms don’t just change the environment of the species in question but also change the conditions that other organisms are exposed to. In this way living things don’t just relate to each other directly—by predation or competing for food perhaps—but also indirectly exert an influence on other species by modifying the conditions in which those species live and sometimes creating new resources. As the human species constructs a particularly complex niche, then this is perhaps most clear in the case of humans. As Ian Rotherham points out, human environmental modification has created the conditions for some other species to flourish. For example, in Sheffield the warm waters of the River Don, once used for cooling in the city’s steel plants, has created the conditions in which forests of figs have grown along the river’s banks. The seeds of these Mediterranean plants would not have been able to germinate were it not for human activity in creating a particular niche (Bramwell, 2015).

Building on this insight, Ellis (2015) uses the concept of niche construction in an extensive survey of the world’s anthropogenic biomes, thereby integrating ecological theory with ideas of anthropogenic change on a planetary scale. He argues that this project would not have been possible with a theory that assumed that humans simply adapt to their environment (Ellis, 2015): “If you are trying to understand why humans alter the environment, if you don’t have a niche construction theory or something related to that, kind of explaining why an organism would alter its environment so much…it’s harder to place humans among other species” (interview, 23 August, 2016). For Ellis, humans are “champion niche constructors”. As explained in chapter three, Ellis has become associated with the idea that humans can direct nature according to their will. But adopting a theory of niche construction does not necessitate this kind of human exceptionalism. Humans may be able to produce environments with more forethought than other species; but constructing environments in general is something common to all living things. Furthermore, as the fig example also shows, the consequences for allowing other species to flourish can be uncontrollable and unpredictable. In what follows, the ability of humans to create novel ecosystems is addressed with reference to the political ecology of two biologists, Ivette Perfecto and John Vandermeer, who draw on Levins and Lewontin’s dialectical approach.

### 6.4: Novel ecosystems: Perfecto and Vandermeer’s agro-ecology

Biologists are increasingly arguing that the planet is dominated by what might be called novel ecosystems, characterised by new combinations of species and arising as a result of human action (Hobbs et al, 2006). And adopting a novel ecosystem approach has led some ecologists to rethink the assumptions of their discipline. Gardner and others (2009) argue that ecologists should accept that there are shifting baselines at work when observing, for example, forest
environments. They cannot treat areas of forest as undisturbed environments that act as a baseline against which they might compare the effects of agriculture; the species composition in the forests is also undergoing change due to human activity.

The rewilding project at the Oostvaardersplassen (OVP) in the Netherlands has been discussed as an example of such a novel ecosystem (see Lorimer, 2015 and Marris, 2011). As explained in chapter three, the example of the OVP is often seen as signifying a shift on the part of conservation biologists from trying to monitor and manage populations—ie more or less keep things as they are—towards one of unleashing non-linear processes which are to some extent autonomous of humans, a shift from the “fixed” to the “untamed” and “spontaneous” (Lorimer and Driessen, 2014, p174). In rewilding there is an emphasis on the processes or services provided by non-human species rather than on the character or composition of these species and ecosystems (see also Lorimer, 2017). Discussing this project, Lorimer (2015) therefore shows that the Oostvaardersplassen defies simple binaries such as that between found and made spaces, secluded and wild, and phenomena of order and surprise. The OVP is “made” in the sense that it is a reclaimed piece of land and is continually modified by humans, but at the same time “organisms and landscapes are given scope to determine their own futures” (Lorimer, 2015, p107); “The wild cows of OVP are introduced to manage a dynamic landscape” (p186). Interestingly, then, for this discussion of non-human agency, these animals seem to have been introduced with the express purpose of letting them modify ecological processes. Although political ecologists might maintain that there is no ecosystem on the planet that exists in isolation from human activity—after all, anthropogenic climate change is modifying the very atmosphere—systems that have more directly combined human and non-human processes have clearly interested geographers. As mentioned in chapter three, this work also has interesting connotations for science studies as it defies the stereotype of a scientist carrying out an experiment in the lab under conditions where they are in control of the object of their study (Lorimer and Driessen, 2014).

Some of the dialectical biologists interviewed share similar interests to those above. Ivette Perfecto’s and John Vandermeer’s research on the ecology of tropical agricultural ecosystems (or agro-ecosystems) is particularly relevant and is referred to in Emma Marris’ 2011 book on novel ecosystems Rambunctious Garden. Perfecto and Vandermeer are scientists and political activists who have both worked with Richard Levins and were also members of Science for the People. Like Levins they have found it impossible to disentangle their scholarship from their activism and, as we shall see, have developed some of his ideas on the spatial distribution of living organisms. Both of them spoke at the 2014 SfP conference, with Perfecto describing how, as part of NWAG (New World Agriculture Group), she was involved in visiting Nicaragua to try to help develop an agriculture programme after the 1979 revolution. NWAG
also attended demonstrations in the US and tried to build solidarity for the leftist Sandinista government. Perfecto explained how she has known Richard Levins since the 1970s, describing how he “had a very big influence in my life because I saw for the first time how you can really combine your passion for science with your passion for social justice” (interview, 22 September 2014).

Like other members of SftP referred to in the previous chapter, Perfecto and Vandermeer recognise that they are far from “neutral” in their approach to the political aspects of research into agriculture. Perfecto is happy to accept that science is political: “I think the questions that I ask are influenced by my political views and my ideology and I think that’s true for everybody…but I think that the difference is that we tend to recognise that and embrace it as well and be more conscious about how…our view of the world influences the questions that we ask and how we ask those questions” (interview, 22 September 2014). Furthermore, for Vandermeer “the claim that you have no ideology is really quite an ideological claim in itself” (interview, 8 April, 2015). They have a “normative preference” for small-scale, organic agriculture that effectively uses ecological principles and local knowledge to maintain production rather than more industrial-scale approaches (Vandermeer and Perfecto, 2012).

Perfecto has argued that synthetic pesticides and fertilisers could be avoided entirely; in a 2007 feature in *New Scientist* she explained that in the developing world the tools needed to practise organic agriculture are more readily available to farmers than expensive artificial chemical products. Furthermore, a major study she was involved in found that organic farms could produce enough calories to more than satisfy the world’s food needs. Rather than people going hungry due to lack of technology, “we are producing enough food—it’s a question of the distribution of that food” (Ivette Perfecto, quoted in Brahic, 2007). The kind of agricultural systems Perfecto and Vandermeer advocate are, they argue “most likely to be constructed by small farmers with land titles, who, in turn, are normally the consequence of grassroots social movements” (Perfecto and Vandermeer, 2008). Therefore, they integrate their interest in collective struggle over environmental issues into their overall analysis, arguing that supporting the aims of farmers and their organisations should play a fundamental, rather than an incidental, role in biodiversity conservation in the tropics (Perfecto and Vandermeer, 2008).

For Perfecto and Vandermeer (2008) conservation biology in tropical regions has prioritised “charismatic” rainforest environments at the expense of looking at what happens in agricultural systems, tending to reinforce the assumption that human activity is simply a threat to pristine environments that impacts upon those environments from the outside. These ecologists’ work on tropical agro-ecosystems therefore adopts many of the concerns that have animated environmental geography in recent years. In particular, they share Lorimer’s (2015) interest in novel ecosystems and in the ways in which the interests of conservation biologists
have been swayed by the appeal of charismatic species. They are broadly in agreement with some of the critiques of dualist approaches to environmental politics common to both Marxist geographers and new materialists.

Although many animal species found in coffee plantations are considered pests of coffee, Perfecto and Vandermeer point out that some also provide autonomous pest control, reducing the need for farmers to apply synthetic pesticides (Vandermeer, Perfecto and Philpott, 2010). But the presence of these species is inextricable from the growing of coffee for humans. Coffee plants are not native to this part of the world (coffee cultivation is thought to have originated in Southern Arabia or east Africa), so like the Heck cattle in the Oostvaardersplassen, these species wouldn’t be where they are without human activity. Indeed, the inherently political implications of understanding ecosystems where human action plays such a prominent role is one of the reasons why these scientists became interested in agriculture. As Perfecto explains: “I like to look at this interaction between the humans and the natural system—the social system, the political system, and the natural system—and so if I work in a reserve, some place in the middle of nowhere, there is still some effect that the humans have on that area but it is not as evident…as it is in an agricultural system” (interview, 22 September 2014).

Agriculture (some types of agriculture more than others) is often understandably seen as having a negative effect on biodiversity. But Perfecto and Vandermeer point out that many species flourish in agricultural systems, often performing roles such as pollination or pest control. This implicitly poses a challenge to the assumption that biodiversity is something that happens where agriculture is absent. They also touch on the question of what might be described as the agency of non-humans in these systems, including the capacity of such systems to control pests (see following section). Although not adopting the term agency, Perfecto describes her research as “trying to understand what all this diversity is doing in the agro-ecosystem? What is the function of biodiversity?” (interview, 22 September 2014). The biologists avoid conflating wildlife with wild spaces or wilderness, a dualistic way of dividing up space that new materialist inspired geographers have also opposed (see Whatmore and Thorne, 1998).

This thesis began with the case of the northern spotted owl, a classic example of how a debate over wildlife conservation became a heated conflict in the 1990s as the Wise Use movement mobilised local workers in defence of the logging industry and environmental groups took direct action to try to defend the forests. Given that it cannot be understood without reference to the wider context in which it took place, such a debate demonstrates the need for a political ecology. For Foster (2002), policies at the local and national level alongside economic trends such as mechanisation, which in this case made timber workers more fearful about their job
security, influenced ideas about what should happen to the forests. Perfecto and Vandermeer’s research on coffee ecosystems similarly integrates a diversity of human and non-human processes that influence such systems. These human processes occur at global scales: climatic change, geopolitical arrangements and trends in coffee consumption and at local scales: changes in individual farmer preference and national or regional agricultural policy.

Neil Smith might further draw attention to the ways in which the profit motive shapes what happens in a forest or a coffee plantation by arguing that such environments are “produced”. As discussed in chapter two, this way of thinking involves a sharp break with the assumption that areas of ancient forest are wilderness spaces existing prior to human influence; such an assertion is an ideological commitment, kept in place by scientific and literary traditions and adopted by some environmental activists. As Smith argues, capitalism tends to turn the use values provided by, in the forest example, a forest into exchange values—by applying labour—as from the point of view of a capitalist drive to realise a profit, the trees in the forest are valued only as a source of timber (Smith, 2008, p79).

Harvey and Ollman’s relational dialectical approach, with its focus on processes over things, is useful here. According to this approach, a place such as a forest or a coffee plantation should be seen as constituted by relations rather than treated as a “thing” with definite boundaries. These diverse processes stretch beyond a specific locality to produce a particular type of ecosystem (see Braun, 1998). This emphasis has the advantage that it shows how processes that might operate at a global scale interrelate with those at a local level. As interpreted in this thesis, Ollman’s approach does not simply mean that the context influences what happens in a locality from the outside. Instead, it means that the locality is itself constituted by diverse processes: specific ecosystems are dynamic as they express the contradictions and tensions that result from the multiple interacting processes that constitute them. Such a way of thinking avoids making a sharp distinction between the global and local.

Furthermore, following Swyngedouw’s example of the socio-natural processes that produce a city’s water supply (Swyngedouw, 1996; 2006), it is useful to understand novel ecosystems, like those that Perfecto and Vandermeer focus on, as constituted out of both human and non-human processes. Viewing human and non-human influences in these ecosystems as fundamentally entwined already presents a challenge to the idea that scientists are disinterested observers of the natural world. On one level anyone who drinks coffee is themselves a part of the global networks of coffee production that influences what happens on a plantation in Brazil. And scientists studying agricultural systems will almost inevitably have some interest in social justice and some opinion on how food and other agricultural commodities should be grown and distributed.
6.4.1: Socio-natural complexity

Much of Perfecto and Vandermeer’s work involves ascertaining the interactions between different biological elements in an ecosystem, where different species can often interact in complex ways and ecological processes such as mutualism, parasitism, predation and competition are all evident (Vandermeer, Perfecto and Philpott, 2010). For example, they explain that the ant *Azteca instabilis* nests in trees on coffee plantations and that it has a mutualistic interaction with another small insect called the green coffee scale (*Coccus viridis*). Each species benefits from the other’s presence: the ants scare off predators of the scale and in turn the scale provides honeydew for the ant. This allows the scale population to grow. But once its population density reaches a particular threshold this can provoke an attack by a fungus called *Cephalosporium lecanii* or white halo fungus which can be seen coating the bodies of the insects. The white halo fungus in turn attacks the fungus that causes coffee rust disease, *Hemileia vastatrix*. Coffee rust disease is a devastating pest of coffee and, at the time of writing, a major epidemic was “destroying the livelihood of millions of small farmers” (John Vandermeer, interview, 8 April 2015). The halo fungus and scale insects, although also both pests, are much less destructive. Therefore, the ant-scale mutualism is essential in allowing the scale population to reach the levels whereby it can provoke periodic outbreaks of white halo fungus, an occurrence thought to be, on balance, useful for farmers in keeping rust disease in check (Vandermeer, Perfecto and Philpott, 2010).

Focusing on just these four species provides only a snapshot of a system that is actually much more complex—where coffee berry borers, leaf mining moths, phorid flies and numerous species of ant are also involved. But Vandermeer and Perfecto argue that it is, nevertheless, still possible to gain useful insights by focusing on one aspect of a wider system (Vandermeer, Jackson and Perfecto, 2014), a procedure that Ollman would recognise as abstraction (see chapter two). Other empirical evidence appears to back up their hypothesis, where ant nests are more common there indeed appears to be a reduction in damage from rust disease. As Vandermeer has pointed out, using insecticides might kill off the insect pest species but this might result in unforeseen problems for farmers if applying them unleashes an outbreak of coffee rust disease (interviewed in Bryce, 2013). This seems to confirm Lorimer and Driessen’s (2014) view that ecosystems are often characterised by “surprise” and that biodiversity conservation has struggled to take account of such surprising events. Perfecto and Vandermeer’s method can therefore start to account for situations where the actions of one species can facilitate the flourishing of another, even leading to sudden increases in population, an example of a non-linear process at work.

Furthermore, recognising that complexity exists in an ecosystem also requires a method of study that takes into account the degree of complexity. In a statement that demonstrates her
knowledge of ecology, animal behaviour and the use of ant species in pest control, Perfecto explains that organisms should not be seen as “separate from the environment” illustrating how the environment of an ant includes other species:

This one particular ant could be a very effective predator of the coffee berry borer but the ant has a parasite and the parasite, when the parasite is present, the ant cannot go out, will stop foraging because it is protecting itself from the parasite... So, when the fly is present the ant is not effective at all. And because the ant is not present other ant species start preying on the coffee berry borer. So, if you just study the ant in the laboratory and look at the different species as separate from their environment you might conclude that having just this one species is the best thing you can do to control this pest but the reality is that that species doesn’t exist in isolation, it exists interacting with a whole bunch of other things—other species (interview, 22 September 2014).

This passage is about understanding a (fairly) complex system where three insect species interact and these interactions influence the damage the coffee berry borer pest does to coffee plants from the point of view of a farmer. But, as mentioned previously, complexity isn’t just something existing “out there” to be observed; it also refers to a predisposition on the part of the scientist to understand the objects of study in a particular way. For Perfecto, what she refers to as a holistic approach and sometimes as a “dialectical/complexity” approach involves understanding what happens to species in situ where possible rather than “just” in the laboratory. Dialectics is simultaneously a method of thinking about the world and, for many, a statement about how the things of the world actually are (Ollman, 2014, p574).

Dialectical biologist Rob Wallace, commenting on Perfecto and Vandermeer’s work, further adds that “self-organised pest control emerges here out of ecological interactions” (Wallace, 2016b, p293). As coffee is not native to this part of the world, Wallace sees these complexes of species and processes as having arisen contingently—they are in a constant process of being formed and reformed—but when such autonomous pest control does emerge it can prove useful to the humans that rely on small-scale farming.

Chapter five referred to an insight into ecosystem dynamics from dialectical biology, the recognition that systems exhibit dynamism as a result of the transformative actions of the organisms that constitute them. Observed ecosystems therefore cannot be seen as in a final state or as stable unless encountered by an external force such as a fire or a flood (Preston, 2003, p54). In a co-authored article, Perfecto and Vandermeer build on this insight by showing how two “syndromes” of agricultural production predominate throughout the world. The first
is “more technified, more mechanised, more chemicalised, more corporate-like” and might be termed industrial agriculture. The second tends to employ more traditional methods, involves smaller farms and, importantly, employs the capacities of organisms themselves, for example by encouraging the types of autonomous pest control referred to above. This second type of farming is described by these authors as doing things the “ecological way” (Vandermeer and Perfecto, 2012).

Although it is possible to imagine a whole spectrum of different ways of farming, Perfecto and Vandermeer argue that in reality any one farm will tend towards one or other of the two extremes. For example, coffee can be grown in monocultures (ie with no other plant species present) where the coffee plants are exposed to full sunlight or the plants can be interspersed with shade-providing trees, a more traditional technique (Vandermeer and Perfecto, 2012). Most of the coffee grown in the world today is the former (“sun coffee”) with Brazil being the main producer, while in parts of Central America and particularly Mexico, shade coffee is the norm. As the authors describe based on their own observations, it can be difficult for individual farmers to switch from one syndrome of production to another. For example, a farmer they know of who decided to cut down the shade trees on his farm soon found problems with weed growth which couldn’t be controlled without herbicides that the farmer struggled to afford. Similarly, there are barriers to going from a sun coffee system to a shade-based system including lack of knowledge of the most appropriate types of trees to grow.

The authors conclude that the socio-ecological system has generated its own dynamics. In other words, rather than a smooth linear progression from one type of production to another being the norm, there are in reality two possible syndromes of production, either one of which is stable but where it takes great effort to move from one to the other. Engels might have referred to this as a shift from quantitative change to qualitative. Perfecto and Vandermeer reflect that external influence, perhaps a change in political policy or climate change, might force agricultural systems to reach a tipping point where they switch from one regime to another. But they expect that change would be sudden rather than gradual. This suggests that the switch from one form of agriculture to another arises as a result of the interaction between the properties of the system and the external influence. Although it is a very different example of these dynamics, the phenomenon is reminiscent of the way the evolutionary biologists discussed in the previous chapter have treated the evolution of species as analogous to trying to push a polyhedron with flat sides as opposed to a spherical object. System dynamics involving two or more alternative stable states, with a tipping point at which one switches to another are already known to ecologists (see Huggett, 2005). What is significant here is that in

50 The trees provide a habitat for the ants that can help control rust disease outbreaks, hence Perfecto and Vandermeer tend to favour growing coffee alongside trees.
Vandermeer and Perfecto’s study they consider a socio-ecological system, incorporating often ignored factors in ecology such as the actions of farmers and economic considerations as well as biological processes such as autonomous pest control.

6.4.2: Population and metapopulation

Perfecto and Vandermeer’s work on metapopulations of species provides another example of how they have integrated social and biological considerations into their outlook. This work expands on the theory of metapopulations associated with Richard Levins (see Levins, 1976 and Begon, Townsend and Harper, 2006, pp180-185). In ecology, a metapopulation is a network of spatially separated populations of a particular species. For example, a species of ant might live in a network of patches of forest separated by areas of agricultural land. Metapopulations are dynamic systems; in each patch the population can fluctuate as individuals are born or die but individuals can also migrate from one patch to another. Species living in the patches of an ecosystem will almost inevitably go extinct locally given a long enough time frame. Leave a population of ants in an isolated patch of forest for 100 years and by chance it is highly likely to become extinct in that patch at some point before the 100 years is over: “local extinctions are common and natural” (Perfecto and Vandermeer, 2008, p177).

The only way for that population to be replenished and the species as a whole to survive in such an environment is to allow the insects to migrate from other patches of forest where there are viable populations. So, there are two opposing forces at work—extinction and colonisation—meaning that the population of a species in each patch of a metapopulation is often far from stable (Begon, Townsend and Harper, 2006).

Many populations of different species have always existed in these types of dynamic networks, but the theory of metapopulations becomes particularly important for understanding biodiversity in tropical environments where it is indeed the case that areas of forest are often separated by a “matrix” of agricultural land. Perfecto and Vandermeer argue that conservationists should, even if they wish to preserve unbroken tracts of unspoiled tropical forest, accept the reality of the situation as it is—in tropical regions the forest is often already fragmented (Perfecto and Vandermeer, 2008; Perfecto, Vandermeer, and Wright, 2009). Therefore, what happens in the agricultural matrix matters; if agriculture provides a hostile environment and prevents the migration of animals this will put the whole metapopulation at risk in the long term (Perfecto and Vandermeer, 2002). This is not an argument that more tropical forest should be cut down for agriculture, Perfecto and Vandermeer are clear that this is not necessary. However “given the fragmented nature of most tropical ecosystems, agricultural landscapes should be an essential component of any conservation strategy” (Perfecto and Vandermeer, 2008, p173).
The metapopulation approach has led Perfecto and Vandermeer to be somewhat critical of the “land sparing” hypothesis. This supposes that intensifying agricultural production will mean that agriculture takes up less space. Producing the same yields on a smaller area will supposedly leave more space for nature. Some popular accounts of land sparing suggest that stretches of land will return to a “wilderness” state if left free from human influence (eg Acton, 2014). In contrast, the land sharing approach of Perfecto and Vandermeer would be more focused on sustainable agriculture that allows agricultural uses and biodiversity to coexist on the same area of land but would leave less space for “wilderness”. By employing their understanding of metapopulation theory, Perfecto and Vandermeer have introduced an argument that is not often considered in this long running debate. Advocates of land sparing or land sharing often implicitly treat the situation as if areas of land with different uses can be hermetically sealed. However, this ignores the issue of the ways in which many living things migrate from one area to another (Phalan et al, 2011). However, leaving patches of “natural” habitat surrounded by intensive agriculture might cause problems for biodiversity, although species might be able to survive in the patches, they will still go extinct if they cannot migrate between them.

As well as identifying weaknesses in the biological theory underlying the land sparing approach, Perfecto and Vandermeer also criticise it for its political blindness: “intensification does not take place in a social/political vacuum”. For example, they point to various studies that suggest that increasing yields by increasing the use of technology on farms can give farmers an incentive to increase production and therefore increase the area of land under cultivation rather than decrease it. Farmers generally act to increase their return on investment rather than aiming to produce a target amount of food (or other produce) as assumed by the land sparing hypothesis (Perfecto and Vandermeer, 2008, p181).

6.5: Conclusion
The opening chapters of this thesis demonstrated that geographers are already considering what it is that non-humans can do. Discussions of non-human agency are ongoing in areas such as animal geography and among those influenced by new materialist thought. It is now not unusual to find discussions among geographers of ecosystems, biodiversity conservation, relationships with animals and even genetics and microbiology. Therefore, there are compelling reasons for geographers to take note of the findings of biologists as they attempt to make sense of today’s environmental problems. But social scientists ought also to recognise that biology itself is changing and is far from unified (Meloni, 2014).
As discussed above, niche construction theory is described as a “neglected process in evolution”. It suggests that organisms might have more “agency” in directing their own evolution than had previously been supposed. The theory is just one of several challenges to old certainties within biology. It is an example of relational, dialectical thinking that also has theoretical and methodological applications for geography. Engaging with such novel ideas within biology could add theoretical clarity to (more than) human geographical notions of agency and open avenues for interdisciplinary work. Indeed, NCT advocates themselves have called for a rapprochement between disciplines, arguing that their theory provides links between evolutionary biology, ecology and the human sciences and undermines some of the ways in which these had previously been separated (Laland et al, 2014; Pigliucci, 2007).

It could be argued that geography and evolutionary biology consider such different timescales that the concerns of the two disciplines are irreconcilable. Evolution operates over timescales of tens of thousands of years whereas geographical studies (in both human and physical geography) tend to concern processes happening over years or decades. If this is so then niche construction is only really useful for its insights in ecology, and geographers ought to ignore applications in evolutionary theory. There are several counters to this argument. Firstly, evolution does often occur on shorter timescales than we might suppose; insects have started to become resistant to the most common insecticides over decades rather than millennia (Russell, 2003). Furthermore, these instances of rapid species evolution are often themselves caused by the actions of humans, as well as having consequences for human societies. Therefore, Edmund Russell uses this fact to make a compelling case that biological evolution ought not to be ignored by social scientists, including in his own discipline, history (Russell, 2003).

As explained in this chapter, niche construction is associated with dialectical biology and with Richard Lewontin’s work in particular. It builds on the dialectical biologists’ inclination to treat the socio-natural world as fundamentally dynamic, to see change as the default state of things and stasis as what requires explanation. The theory is influenced by Marxist understandings of the agency of humans in changing the world around them. But the theory of niche construction remains controversial; hence its followers are “causing a commotion” within biology (Laland, Odling-Smee and Feldman, 2004). Although niche construction theory should not be seen as a “theory of everything” that simply has to be applied to any situation, it has already started to influence thinking in the social sciences including the work of Clark and York, Ellis, Kallis, Stallins and Swyngedouw.

Mainstream thinking in biology has relied on externalist assumptions about the relationship between organism and environment. But these are being challenged by theories such as niche construction, where externalism is no longer seen as adequate to understand fully how species such as earthworms evolve. Instead, some niche construction theorists refer to organism and
environment as two elements that mutually construct each other to such an extent that it does not make sense to talk about an “environment” without the associated organism. A radical interpretation of the theory denies entirely that “the environment” exists, or at least that the environment is something stable and coherent that needs “saving”. Instead, organism and environment can be seen as abstractions from a totality. Bringing work in biology into conversation with the dialectical philosophy of Ollman and Harvey, with its insistence that the world is made of relations rather than things, can illuminate this possibility.

The various contributions of Ivette Perfecto and John Vandermeer discussed here demonstrate how two dialectical thinkers have thought about wildlife in coffee plantations. Although these are clearly environments where human agency has played a major role, a host of other organisms also act in these systems, often in unpredictable ways, whether by causing other species to proliferate or by migrating from one part of the system to another. The work of these two scientists shows how social concerns such as the needs and actions of farmers can be integrated into an overall picture of what happens in these agro-ecosystems along with knowledge of ecology and animal behaviour. The ecosystems they study can, again drawing on the dialectical approach outlined in chapter two, be seen as constituted by multiple social and natural processes. The work of these scientists defies dualist understandings whereby human action is treated merely as a threat to wildlife. The following chapter will show how these theories can contribute to recent debates in geography around the need to develop a more overtly historical approach to socio-natural relations.
Chapter seven explained how dialectical biologists have developed accounts of evolution centred on the active role of organisms (both human and non-human) in shaping environments and how these ideas have been taken up by niche construction theorists. One area where this thinking might be taken forward is in creating an approach to geographies of non-humans that takes seriously the proposal that non-humans are historical agents. Such an approach, it is argued, would integrate insights from political ecology, evolutionary biology and more-than-human geographies.

Political ecology, with its overt references to the wider political forces structuring human-environment relations and its roots in political economy, has already been somewhat influenced by historical approaches. There is already a wide literature on “historical political ecologies” that seeks to understand the temporal processes driving environmental change and that makes use of the theoretical and methodological contributions of historians (see Offen, 2004). However, as explained in chapter one, political ecology has tended, at times, to focus on questions of discourse and representation and the influence these have on how humans manipulate the physical environment rather than on the actions of non-human species. Therefore, the subdiscipline has been criticised for the relative lack of attention given to ecological research in general (Walker, 2005) and to ecological engagements with non-human subjectivity in particular (Zimmerer, 1994). Hobson (2007) suggests that a failure to engage with the subjectivity of non-humans such as animals can lead to them being treated as passive bystanders in political ecologists’ analysis or even that they come to be viewed as “co-oppressors of the world’s marginalised and poor” (p253).

Animal geography, as developed in the past two decades, aims to address some of these omissions in political ecology. These more-than-human geographies have addressed, among other things, issues of animal subjectivity, the constitutive roles of animals in human societies, the role of scientific and other practices in representing animals and the political implications of such practices. Animal geography originated within cultural geography, so it is perhaps unsurprising that animal geographers are often concerned with the ways in which animals are
represented and how social institutions such as zoos shape popular understandings of animals (Anderson, 1998).

However, little of this work is overtly historical. Many of the richly depicted examples of non-human agency within geography consider individual animals (or sometimes plants or microbes) and their effects over short time-scales rather than accounting for the accumulated and directed effects of interactions between species and environments over time. For example, Lorimer’s work on non-human charisma considers the fleeting effects of individual representatives of particular animal species on the humans with which they come into contact (Lorimer, 2007).

However, this is a problem that animal geographers recognise and are seeking to change. Wilcox and Rutherford, in their recent edited collection (Wilcox and Rutherford, 2018) refer to the need for a more historical animal geography, whereby animals (and other non-human species) are perceived as having a history and where “human and non-human agencies have shaped each other through time” (Wilcox and Rutherford, 2018, p3). They also address the political consequences of not seeing animals in this way. The contributors to this collection have pointed to several ways in which a more historical approach can extend the insights of animal geography. For example, work on pet ownership has engaged with spatial questions as it concerns animals in the home but this work could also be built upon by asking questions about the point in history at which animals first became pets. Answering this question involves charting the development of a particular type of culture that values relationships with certain types of animals rather than seeing that culture as universal (Howell, 2018).

This chapter, based on my own contribution to that collection (Royle, 2018), will address the reasons why geographers might want to integrate the historical approach of some interpretations of political ecology with more-than-human thinking in order to counter some of the human exceptionalist narratives of the Anthropocene. The chapter will use the example of the ways in which animals are represented in natural history museums to show how ahistorical accounts of animals are maintained by cultural practices and will offer a way forward based on Charles Darwin’s historical and materialist writings on earthworms and the more recent contributions of niche construction biologists around earthworm evolution. It will conclude with some comments on what a niche construction approach means for debates around human nature, also of course highly relevant to discussions of the Anthropocene, by showing how evolutionary biology has suggested a non-reductionist route through which humans might have developed differentiated abilities to modify the biosphere that does not rely on exceptionalism.
7.1: Human exceptionalism

Wilcox and Rutherford frame their work in opposition to “human exceptionalism” (2018, p1). This leads us back to discussions of the Anthropocene. As demonstrated in chapter three, discussions of the proposed epoch have involved a paradox: while renewed concerns over environmental threats have brought home how dependent humans are on the rest of nature, “this threat also appears to be prompting a renewed commitment to the idea that humans possess a unique capacity to control our environment” (Anderson, 2014, p13). So, humans are seen as uniquely able to modify the biosphere, even to the extent of being able to push the globe into a new epoch. But, while there is an emphasis in some of these accounts in humans’ ability consciously to manipulate the biosphere, humans are also seen as the object of natural forces over which they have little control. This has implications for environmental theory and politics as it brings with it the related notion that the non-human world can be freely manipulated in line with human wishes and desires (Anderson, 2014). This view of unprecedented human capacity to direct what happens to the rest of the biosphere is indeed evident in some discussions of the Anthropocene, for example in Ellis’ assertion that the “environment will be what we make it” (quoted in Collard, Dempsey and Sundberg, 2015, p324). For Anderson, the Anthropocene paradox is itself rooted in human exceptionalism, “the positing of a separation between active human subjects and passive non-human objects” (Anderson, 2014, p5). One particular way in which this exceptionalism manifests itself is in perpetuating the view that animals do not change through time as human societies do. The status of a historical subject with the capacity to shape history is reserved for humans whereas non-humans are assumed not to be historical actors.

Criticising human exceptionalism and its role in discussions of the Anthropocene, Rutherford (2018, p202) uses recent work in historical geographies to critique attempts at “resurrection ecology”. Such projects are referred to as “resurrection” as they aim to restore extinct species to life by human endeavour, for example by editing DNA from museum specimens into the genomes of closely related extant species. For Rutherford, these projects offer “human mastery over nature”, suggesting that the non-human world can be manipulated at will with the right technology and enough money. As well as attempts to bring back extinct species by cloning or gene editing, Rutherford gives the example of selective breeding of Heck cattle (Rutherford, 2018, pp201-205). Lorimer might disagree that Heck cattle breeding is an example of human mastery, given that attempts to reintroduce this species have been characterised by surprise as well as order and control (Lorimer, 2015). Nevertheless, for Rutherford, such projects are problematic as they do little to address the human-animal relations that are driving species extinction in the first place.
As she is writing in a book about historical animal geographies, Rutherford is almost apologetic for raising the subject of the Anthropocene. A proposed epoch that is often discussed with reference to the future of the planet, may “seem quite distant from the subject of this book” (Rutherford, 2018, p201). However, the Anthropocene is indeed a matter for historians. What is needed is an analysis of how the proposed Anthropocene epoch began, when it began and what processes led to this situation—as it becomes more and more commonplace to argue that the Anthropocene has already started—rather than treating the epoch as either an imminent crisis or a hopeful scenario of future human domination over nature.

Human exceptionalism is reinforced by cultural representations of animals. As Moore (2015, chapter 8) argues, rather than simply being expressions of ideas distinct from material reality, these practices of representation both emerge from and reinforce certain ways of treating non-humans. Ideas about animals have real consequences for how humans understand and relate to the rest of nature. In what follows this chapter therefore addresses the way in which animals are presented in museums such as London’s Natural History Museum. If scientific norms have served to establish a proper place for animals, the presentation of animal specimens in a museum can similarly be thought of as a form of cultural practice.

7.2: Museums and animal representation

London’s Natural History Museum owns more than 20 million animal specimens. Many of them are preserved in ethanol and therefore known as the spirit collection. The collection includes rodents, reptiles, fish, amphibians, octopuses and larger animals such as a 3m long Greenland shark and an 8m long giant squid called Archie. Although part of the spirit collection is open to the public, most of it is kept behind the scenes on over 27km of shelving. Items are sometimes lent out for scientific research, or, preferably from the point of view of the museum as some of the specimens are rare or delicate, researchers visit the museum in order to make use of the collection. Some items in the museum’s possession were collected by Darwin, including fish specimens brought back from his five-year long voyage on The Beagle.

The ways in which animals feature in natural history museums can influence the way people think about them (Kalof, Zammit-Lucia and Kelly, 2011). For example, museums such as this also play a role in what Philo and Wilbert (2000) might refer to as the spatial ordering of animals. The jars in the spirit collection as well as the exhibits in the public galleries are arranged according to the taxonomic system established in the 18th century by Carl Linnaeus. Exhibits about mammals are found in one part of the museum and those about insects in
another. The animals are therefore represented as distinct both from their own habitats and from other organisms with which they would interact in the wild.

The museum and the collection featured in the novel *Kraken*, by the weird fiction author China Miéville. Miéville imagines the giant squid mysteriously going missing and the museum’s curator Billy being troubled by the sounds of grinding glass on distant corridors as the specimens appear to come to life:

> The corridor opened out, not a room but a sudden large hallway. It was stacked quite full of taxidermy, charnel Victoriana. Mammal heads watched from walls, like a hundred Faladas; bison stiff as ageing soldiers by a plaster iguanodon and a tatty emu… A clink, a clank. Under the striplights the stuffed bodies shed hard shadows. Billy heard another tiny noise. It came from the dark by the wall, deep in the specimen undergrowth (Miéville, 2010, p30).

Indeed, as Miéville expresses, seeing so many dead animals curled up in an odd assortment of glass jars, with yellowing handwritten labels giving the Latin species names can be an eerie experience. Furthermore, by being invited to view dead animal specimens, viewers are encouraged to see animals as objects for our observation. One consequence of the practice of displaying animals as museum exhibits lends itself to an understanding of animal life as ahistorical. Human society might have changed since 19th century explorers like Darwin travelled the world searching for specimens, but, due to the emphasis on preservation in museums, we are led to believe that the animals remain the same. Such ahistorical conceptions of animals are not only blind to the ways in which animals have changed over time but would also seem to foreclose any discussion of how humans and animals have influenced each other throughout history.

In fairness, museums are often aware of the importance of how they represent animals. Although they need to preserve animal specimens, the London Natural History Museum also has a mandate to facilitate scientific research. This tension between the museum’s desires to represent the animals of the past and to foster an understanding of living, breathing animal life was highlighted by the recent redevelopment of the museum’s central Hintze Hall. The project involved removing “Dippy”, the famous cast of a Diplodocus skeleton and replacing it with a real blue whale skeleton suspended from the ceiling (“a perfect symbol of…hope”) along with other new exhibits that tell “the dramatic story of evolution, diversity in the world today and our urgent role in the planet’s future” (Natural History Museum, 2016).

Nevertheless, exhibits like the spirit collection demonstrate the resilience of the notion of humans as observers of passive non-human natures and how this is maintained and expressed
in cultural practices. If humans are seen as dynamic while other animals are static this runs the risk of enforcing a form of human exceptionalism whereby the agency of other animals is not fully accounted for. As animal geographers have long recognised, these ways of representing and of understanding animals can also feed into ideas about “nature” generally, reinforcing the binary separation of nature and human society. As we will see, in the case of Darwin’s specimens, this is ironic indeed. It was Darwin who gave us the idea that life forms have a history.

7.3: Darwin’s small agencies of earthworms

Before Darwin’s theory of evolution by natural selection, life had been assumed to be typified by invariance and stability. However, according to biologist Ernst Mayr, Darwin “introduced historicity into science” by showing how species, rather than being fixed and static, could evolve into radically new forms (Mayr, 2000). As discussed in chapter two with reference to the scientific influences on Engels’ *Dialectics of Nature*, evolution involves irreversible change and development. Darwin’s theories were part of a shift in emphasis towards understanding such phenomena that also took place within other scientific disciplines in the 19th century.

Darwin recognised that in a population of organisms of a particular species there is often variation in the characteristics (phenotype) of individuals. Those individuals whose characteristics are best suited to their environment are more likely to survive and to produce offspring. But for evolution to occur, characteristics also need to be heritable (capable of being passed from a parent to its offspring). Over time certain phenotypes will become dominant in the population by this method. Although natural selection is sometimes termed “survival of the fittest” (a term coined not by Darwin but by Herbert Spencer), “fitness” in biology is understood relationally, it refers to how suited an organism is to its environment rather than being an inherent property (Mayr, 2000).

Darwin was not the first to argue that change could occur within a species. There were pre-Darwinian evolutionists, notably Lamarck (Angus, 2017, pp33-35). And the fact that certain characteristics of animals could be artificially selected for was well known by lay people such as fancy pigeon breeders, who Darwin associated with (see Desmond and Moore, 1991, pp425-430). However, Darwin’s theory of evolution by natural selection provided answers to two questions: why do organisms seem well suited to their environment? And how can we

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51 In sexually reproducing species an individual might also increase its chances of reproducing by being more able to attract a mate than their peers.

52 Fitness is defined as how successful an organism is at reproducing.
account for the diversity of living things? Answers were provided respectively by the theory of natural selection and by the realisation that one species could evolve into another over time (see Pigliucci, 2007).

At the time when Darwin was writing, the foundations of biology were being shaken. In the 18th century, human exceptionalism had taken the form of Cartesian dualism, the idea, associated with Descartes, that humans—uniquely among animals—possess a soul and/or the capacity for rational action. However, by the beginning of the 19th century “the idea of an immaterial soul or mind was actively rejected” (Anderson, 2014, p6). Cartesianism had given way to a more materialist approach rooted in the scientific practices of the day. This is not to say that human exceptionalism was dispensed with; rather, it persisted in a different form with human distinctiveness thought of as having emerged from the physical differences between humans and other animals (Anderson, 2014, pp9-13). Therefore, Anderson argues, those who attack “Cartesian” dualism ought to note that they are dealing with a doctrine that has itself gone through historical changes. Furthermore, as Juanita Sundberg (2014) reminds us, the modern separation of nature and culture often referred to as “Cartesian”, far from being a universal foundation of thought, was specific to Western societies.

Darwin himself returned throughout his life to debates about whether living things are animated by a vital force that is instilled in them from without or whether they contain an inherent vitality. As a young man observing pollen grains bursting under a microscope he noted: “the matter inside seemed to have a self-activating power” (Desmond and Moore, 1991, p82). Indeed, this was a key question for 19th century thinkers. Many of Darwin’s contemporaries maintained that matter was essentially inert, with the vital force in living things given by God. However, some radicals, including Darwin’s mentor Robert Grant, sought to explain liveliness in matter according to naturalistic principles without the need for celestial intervention. This materialist and historical approach would be evident in Darwin’s own writings for the rest of his career.

Continuing this interest in the liveliness of non-human organisms, towards the end of his life, Darwin published an investigation into the lives of earthworms: *The Formation of Vegetable Mould through the Action of Worms with Observations on their Habits* (Darwin, 1881, p2). The book was a bestseller, with sales at the time actually rivalling those of his better known *On the Origin of Species* (Feller et al, 2003). Devoted almost entirely to earthworms, the book

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53 As Darwin’s biographers point out, Grant’s view fitted well with the political views of the liberal intellectual circles with which both Darwin and Grant associated. It suggested that people were capable of self-improvement, providing an analogy that suited the emerging industrial class when old institutions such as the church and aristocracy were losing some of their authority (Desmond and Moore, 1991, p223).
includes the results of experiments on live worms performed by Darwin in his home, observations of worms in the garden and notes on their historical activities. Darwin’s writings are discussed here as they offer an alternative, more historical, way of describing the actions of non-human animals that recognises the role worm action plays in human societies. The earthworm example is, as discussed in the previous chapter, also popular among niche construction biologists. Furthermore, the historical approach expressed in Darwin’s writings was influential to Marx and Engels’ outlook.

Darwin was interested in whether worms display evidence of “intelligence”. He described how the animals responded to vibrations, appearing to feel “aroused”, “surprised” or “distressed” by the presence of bright light and how they reacted to being played music (1881, p21). Darwin even explicitly compared the worms’ actions to those of humans. He described how, when a worm pulls a leaf into its burrow, it acts “in nearly the same manner as would a man” in solving this problem (1881, p312). The possibility of worm intelligence was a key reason for the book’s surprising popularity with the Victorian public. Worms had been considered ugly and useless, especially given their limited sensory abilities and the benefits of earthworms to gardeners were not well known even into the 20th century (Feller et al, 2003, p40). It should be cautioned, though, that Darwin hastily attributed intelligence to worms and today his writings would be seen as needlessly anthropomorphic (Feller et al, 2003, p43). However, it is interesting that, given the modern association of “work” with human enterprise, the naturalist refers repeatedly to the “work” carried out by the worms. For example, they are described as performing the work of drawing leaves into their burrows during the night (1881, p61).

As Darwin also described, stones left on the surface of soil would, over decades, sink into the ground due to the actions of digging worms, bringing fresh soil to the surface and creating tunnels underneath objects that occasionally collapsed. For Darwin the whole of the topsoil is in “constant, though slow movement” due to the actions of worms (1881, p305). Archaeologists ought to be thankful to the animals, he wrote. They have preserved Roman ruins by covering them with earth. However, their activities are also destructive. Their steady burrowing had affected the Neolithic earthworks at Stonehenge, causing some of the outer stones to collapse and become partially buried (1881, pp154-158).

The lives of worms are also entwined with those of humans in other ways. Darwin described how worms tunnel into the soil and produce casts on the surface by ingesting a mixture of soil and vegetable matter and excreting it. For him it was fascinating to think that “the vegetable

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54 Darwin tested this by setting out a “worm stone”: a flat round stone on the top of the soil with a hollow centre containing an instrument for measuring how far the stone had sunk into the ground. A reconstruction of the experiment can be seen in the grounds of the family home at Down House in Kent so the continued digging activities of the descendants of Darwin’s worms can still be observed.
mould [topsoil] over the whole country has passed many times through, and will again pass many times through, the intestinal canals of worms” (1881, p4). As Darwin convincingly demonstrated, worms play a role in constructing human societies. They produce “wonderful” transformations in farmers’ fields, turning rocky ground into fertile farmland. Strikingly, in his concluding remarks he states that the earth has been “ploughed” by worms since long before humans invented the plough (p313). This suggests a perspective quite different to what Haraway criticises as productivist logic, whereby non-human nature is the raw material on which human enterprise acts (Haraway, 1989, p13).

In the introduction to their edited collection, Wilcox and Rutherford (2018, p2) write that animals leave little physical trace of their activities for historians to learn from, and they complain that animals don’t produce their own archives or pass down memories from one generation to the next. However, Darwin’s account provides a counter-argument to this unevidenced claim. It shows how the activities of other species have actually, in many cases, had a significant effect on their environment that can indeed still be detected by historians, even that their influence can be seen on the Roman ruins that conventional historians might take an interest in. Darwin’s views on worms suggest that, far from being hidden from contemporary observers, the activities of animals in the past are very much still observable today due to the effect creatures have on the landscape.

As the Marxist biologist Stephen Jay Gould (2007) points out, Darwin’s work demonstrates a concern with the way in which small actions by worms can produce large-scale directed change when aggregated over time. Small quantitative changes could trigger qualitative shifts, as evidenced by the collapsing stones at Stonehenge. Although a book of observations of worms in the garden might be seen as a departure from work that had addressed grand questions—the origin of species, the evolution of humans—and a turn towards the mundane, Gould says that Darwin was actually pointing out something key to his whole way of thinking. In evolutionary theory species might only change very slightly with each generation, but over millennia, evolution can have a spectacularly transformative effect. Failure to appreciate this led to misunderstandings and even hostility towards evolution in Darwin’s own time: “an…inability to sum up the effects of a continually recurrent cause, which has often retarded the progress of science” (Darwin, 1881, p6).

More recent investigators have described earthworms and other soil-dwelling invertebrates as ecosystem engineers—species that modify the resources available to other organisms by changing the physical, chemical or biological environment. As Lavelle et al (2006) confirm, earthworms break up soil particles into smaller pieces making the soil more amenable for crop plants to establish roots. They “dramatically change the structure and chemistry of the soils in which they live” by mixing organic material with the soil, burrowing and casting (Odling-
Smee, Laland and Feldman, 2003, p11). The physical effects of worms can also be seen at much larger scales, for example when their actions lead to soil erosion and soil creep on sloping land (Lavelle et al, 2006, p8). However, Feller and others (2003) suggest that Darwin’s own work on worms remains overlooked as agricultural scientists have become preoccupied with chemical inputs rather than soil composition or soil dwelling organisms (2003, pp29 and 44). For these authors there is likely to be a revival of awareness and interest in the book in line with an increased interest in organic farming.

However, as discussed earlier with reference to the limitations of new materialist accounts, emphasising the active role played by non-humans in providing a “service” can have problematic implications. Where the input of non-humans into, for example, agriculture, has been recognised, various governments have been quick to attempt to incorporate their activities into a capitalist framework in the form of “natural capital”, where putting a price on “ecosystem services” is suggested as a solution to biodiversity loss (Monbiot, 2014; Lorimer, 2012, p603).

Drawing on Darwin’s references to the “small agencies” of the worms, Jane Bennett (2010) and Elizabeth Grosz (2011), two writers in the new materialist tradition, have both referred to Darwin’s work, particularly his comments about the self-activating power of matter. As explained in chapter three, the work of both, although sometimes described as neo-vitalist, has diverged from traditional vitalism. Both, like Darwin, tend to see the vitality of things as arising from the properties of matter rather than viewing the former as bestowed on matter from the outside. In her book Vibrant Matter (2010, chapter 7), Bennett makes use of Darwin’s writing on the “small agencies” of earthworms, addressing the role of worms in human societies as well as his comments on worm intelligence. Bennett asks whether the ability of worms to act makes them like humans or whether the observers’ ability to engage with the agency of worms is clouded by an anthropomorphism that obscures types of agency that do not operate in the same way as human action. Agency, for Bennett is, rather than being a possession of humans, distributed across a network. Human agency must work in concert with a host of other agencies at work in the world. Bennett notes how the way in which worms allow plants (including crops) to grow makes human action reliant on them. The animals should therefore be seen as members of a “public” in an interpretation of the political that is expanded beyond humans (Bennett, 2010, pp103-104).

The emphasis on materiality and non-human agency within new materialist work is to be welcomed. However, this work has done relatively little to address the directedness of social relations and the historical processes that have allowed relationships to develop. Rather than discussing how worm agency has been utilised by different human societies throughout
history, Bennett is more focused on the way in which networks of worms, humans and other agents hang together in the present moment (see also chapter three).

By contrast, evolutionary biology offers a more historical approach. As described in chapter six, earthworm evolution is one of the key examples used by niche construction biologists to demonstrate how their theory challenges existing thinking—although Bennett does not mention these contemporary debates among biologists. When niche construction biologists refer to the actions of earthworms, in contrast to much contemporary animal geography, they consider earthworms as a species rather than as individual animals. The earthworm example is one of change occurring over the long term. The effect the worms have on the soil takes decades and the evolution of the worm’s physiology has taken millions of years. For niche construction theorists the actions of worms have not only undermined buildings but have also played a role in their own evolution. They point out that earthworm evolution cannot be understood without taking into account the way worms have modified their immediate environment and treating this as itself an evolutionary process (Odling-Smee, Laland and Feldman, 2003, pp374-376).

Niche construction theory has already been outlined in the previous chapter. However, it is important to emphasise here that it is inherently a theory of how organisms change over time and the theory does not make sense without considering a temporal dimension. As Brandon and Antonovics (1996, p174) explain, from an atemporal point of view, aspects of the environment can be measured independently of the organism that inhabits it. For example, one might measure the temperature, moisture content of pH of soil and treat these properties as independent of the living organisms that dwell there. However, when considering evolution over time, the “environment” becomes both cause and effect of evolutionary processes so cannot be seen as simply independent. A temporal dimension, as well as geographical space and scale, needs to be taken into account in order to understand how organism and environment mutually construct each other. This seems analogous to Jason Moore’s point about society and nature, that they cease to be simply a relation and become a dialectic when they are treated in a way that addresses their dynamism, ascertaining the “laws of motion” of socio-natures (Moore, 2017b, p295).

Darwin’s materialist outlook has influenced new materialists. However, as the following section explains, Darwin is also a point of reference for Marxist, dialectical thinkers. This shared intellectual heritage suggests that there may be fewer differences between the two theories that is often supposed. It might provide the basis for developing a Marxism that accounts for the materiality of non-human life.
7.4: Marxism and Darwin

Both Marx and Engels were familiar with Darwin’s work and, despite his liberal politics and enthusiasm for Malthus, they were enthusiastic about its implications. Indeed, both read *On the Origin of Species* (published in 1859) and described it as “the basis for our views” (Foster, 2000, p197, Angus, 2017; Royle, 2014). The relationship between the two thinkers is now fairly well-known (although much has been made of the myth that Marx wanted to dedicate *Capital* to Darwin—now conclusively disproved, see Blackledge, 2002, p11). The intention here is not to rehearse these arguments at length. Rather it is to remind readers that Darwinism is an influence on Marxism as well as for the new/vital materialists, although this Darwinian influence has been downplayed in Western Marxism following Lukács’ apparent reject of the dialectics of nature. As Clark, Foster and York (2007) argue, Marx’s debt to Darwin is evidence of their shared turn towards materialism. Both developed a philosophical approach that did not require the introduction of a spirit to animate matter as in the religious and idealistic ideas of their time. Both rejected crude teleological accounts of evolution progressing towards a predefined end point.

The materialism of both Marx and Darwin was a historical materialism. If the historical role of animals has been somewhat overlooked within animal geography, a historical approach has been absolutely central to ecological Marxist thinking on ecological questions, for example Loftus describes historicising nature-society relations as the first step in Smith’s project of developing the production of nature approach (Loftus, 2017, p2). As shown in chapter three of this thesis, ecological Marxism is founded on a discussion of how different societies throughout history have produced different types of environments. It treats these relations as always transitory. Marx and Engels, then, apparently saw an analogy between Darwin’s account of species changing through time and their own approach to human history. For Engels in particular, the engagement of the natural sciences—especially Darwin—with notions of historical and unidirectional change was a major influence on his unfinished attempt at a dialectics of nature. Engels points out that Linnaeus divided up the living world into “unalterable organic species”. In contrast, Darwin demonstrated that:

Nature works dialectically and not metaphysically… [nature] does not move in the eternal oneness of a perpetually recurring circle but goes through a real historical evolution. In this connection, Darwin must be named before all others. He dealt the metaphysical conception of nature the heaviest blow by his proof that all organic beings, plants, animals, and man himself, are the products of a process of evolution going on through millions of years (Engels, 1970 [1880], emphasis added).
Furthermore, an assertion that “history matters” has, as described in chapter five here, also been one of the key contributions of the dialectical biologists and their adherents. Levins and Lewontin (2006) have made their historical approach one of the tenets of their programme for biology. However, as Gould also recognised, there are different interpretations of Darwinism: there is a gradualist Darwinism that emphasises slow change and one that takes into account abrupt shifts in evolution (Blackledge and Kirkpatrick, 2002).

This chapter has so far emphasised the commonalities between human and animal agency. It has shown how efforts to historicise animals, with the example of Darwin’s writings on worms, can offer an antidote to the kind of exceptionalist thinking that treats only humans as historical subjects. However, while opposing the view that humans are able to manipulate the rest of the biosphere at will, there are reasons why social scientists might want to distinguish the human capacity to transform the environment from that of other species. It is undoubtedly the activities of humans (or rather, the human-initiated capitalist system) that are at the root cause of climate change, plastic in the oceans and biodiversity loss, although other species play a role in these phenomena. John Bellamy Foster and others may be correct to see the ability to create a rift in the socio-natural metabolism as a uniquely human trait. Therefore, there is a need to address—with some comments on human “nature”—this apparently differentiated capacity to disrupt socio-natural relations.

As described in chapter three, some commentators on the Anthropocene have argued that there is something innate in “human nature” that compels the burning of fossil fuels (see the critique in Malm and Hornborg, 2014, p63). They have adopted a determinist view that puts humanity on a pathway towards an inevitable Anthropocene catastrophe. However, this is a long way from the sophisticated discussion of human nature to be found in the work of Marx and Engels. As we shall see, the work of the dialectical biologists, some of whom have attempted to integrate their understandings of evolution with thinking on human culture and social relations is also informative in addressing these debates.

7.5: Human nature in the Anthropocene

Political ecologists have already done much to refute apolitical viewpoints by addressing the social roots of ecological degradation rather than seeing it as the outcome of, for example, human overpopulation (Robbins, 2012, pp14-18). Indeed, political ecology itself originated out of a response to “alarmist and universalist approaches to human behaviour” that, in essence, often blamed environmental problems on human nature, particularly the behaviour of people in the Global South (Offen, 2004, p24).
This is a subject that has been discussed and debated at length by Marxists. But, in essence, for Marx, human nature, rather than being fixed, remains malleable and develops partially as a result of the way in which humans manipulate the environment which influences human development (Sayers, 2005; see also the discussion of human nature in Molyneux, 2012). However, Marx does not simply reduce human nature to social relations or say that there is “no such thing as human nature”. Norman Geras convincingly refutes this assumption, stating that Marx’s sixth thesis on Feuerbach, where the latter states that “the essence of man…is the ensemble of social relations”, “does not show Marx rejected the idea of a human nature” and that Marx “was right not to do so” (Geras, 2016 [1983], pp29 and 116). As Geras clarifies, it is possible to assert the existence of a human nature while also refusing to abstract this nature from historical processes. Marx also refers, in Capital, to the “species being” of a human and discusses the differences between humans and other animals, pointing out that humans are unlike bees and spiders in that humans consciously and intentionally modify their environments (see chapter two).

In the essay “The Part Played by Labour in the Transition from Ape to Man”, Engels further argues that the use of tools played a role in human evolution by allowing for the development of larger brains, therefore effectively saying that humans have driven our own evolution in a particular direction by manipulation of the external environment mediated by labour. As discussed in chapter two, this is one of the more useful insights arising from his study of the dialectics of nature (Engels, 1939). For Engels, in this text, the distinction between humans and other animals lies in the ability to modify the biosphere (Sayers, 2005) but this is also the source of human differentiation. The transition “from ape to man” therefore represented a qualitative shift in the ways in which humans relate to and modify the rest of nature. So, Marx and Engels already laid the basis for an understanding of the ways in which a further shift might have taken place as planetary conditions tipped over from Holocene to Anthropocene. Elsewhere in his notes for Dialectics of Nature, Engels criticises those who refer only to the determining influence of “nature” on humanity and neglect the human modification of nature, writing:

It is precisely the alteration of nature by men, not solely nature as such, which is [the] most essential and immediate basis of human thought, and it is in the measure that man has learned to change nature that his intelligence has increased. The naturalistic conception of history, as found, for instance to a greater or lesser extent in Draper and other scientists, as if nature

55 This is in response to Althusser, who argued that in Marx’s later writings he changed his outlook, abandoning his interest in the human essence and coming to see humans as nothing more than the outcome of the social relations in which they exist (Geras, 2016 [1983], p52).
Chapter 7: Historicising political ecologies

exclusively reacts on man, and natural conditions everywhere exclusively determined his historical development, is therefore one-sided and forgets that man also reacts on nature, changing it and creating new conditions of existence for himself. There is devilishly little left of “nature” as it was in Germany at the time when the Germanic peoples immigrated into it. The earth’s surface, climate, vegetation, fauna and the human beings themselves have infinitely changed, and all this owing to human activity, while the changes of nature in Germany which have occurred in this period of time without human interference are incalculably small (“Notes and Fragments” to Engels, 1939 [1883], emphasis in original).

As discussed in chapter three, Erle Ellis has more recently also referred to the need to understand the differentiated capacity of humans to “change to earth” as a key question for ecologists. Ellis also recognises the need to provide an explanation that is not reductionist, in other words that doesn’t reduce the question to one of differences in the genome or other biological differences between humans and other species (interview, 23 August 2016). For Ellis, niche construction is a key element of his understanding of how humans have modified biomes rather than simply adapting to their immediate environments (the original concept was meant to apply to all living things but Ellis is particularly interested in human environmental modification).

However, a major limitation of Ellis’s work is that, in contrast to historical materialist approaches to this question, he has had very little to say about social structures among humans and the role these might play in enabling or driving modification of the biosphere. His work is in contrast with Malm, for example (2016), who sees climate change as rooted in (fairly recent) class struggle over the adoption of steam power in industry. Consequently, Ellis’s work can be criticised for its tendency to naturalise climate change, emphasising long-term changes to the biosphere over more recent phenomena, although in fairness he does note that recent climate change is quantitatively greater than in the past: “Really the amount of change going on now is orders of magnitude more than before… But the idea that humans are just recently becoming this transformative force in their environment is not true. Humans have always altered their environments—a lot” (interview, 23 August 2016).

Some of the biologists mentioned in the previous chapter, by extending the insights of the niche construction approach, have come to similar conclusions about the importance of the human relationship with the environment in the evolution of the species. Humans, like all living things, construct a niche. But the human niche can encompass languages, cultural practices and the environments humans create including buildings, cities and institutions. Although human environments are more complex and varied than those of any other animal,
for Chris Sinha: “humans are just niche constructors, that’s what humans are” (interview, 19 August 2014). As with other species, niche construction can, in turn, influence the way in which the species has developed.

To use an example related to Sinha’s work in linguistics, not all human cultures share the same metaphors for understanding how time passes. All, it seems, have some notion (expressed in language) that a human life involves a succession of events such as birth, adolescence, ageing, etc. However, the notion that time is cyclical, and associated cyclical expressions such as “all year round” and “round the clock” may be specific to cultures that use clocks and calendars rather than universal (Sinha and Gärdenfors, 2014). Sinha argues that cultures that have surrounded themselves with clocks have developed a cyclical understanding of time, making itself felt in the language used to refer to the passage of time. For Sinha, this conclusion is in line with Marxist ideas about alienation; the objects that humans produce through the labour process come to confront them as alien forces. It also chimes with the view of human nature outlined above, that human “nature”, rather than being something fixed, is able to adapt to changing external environments and that humans construct their nature by modifying the externalised world. If we follow Sinha’s way of thinking, it is not simply the case that human nature has initiated the Anthropocene, Anthropocene conditions might also be driving changes in the human species.

Furthermore, this type of dialectical thinking offers an interpretation of how humans have evolved to be different from non-human ancestors that does not reduce this question to one of differences in the genome. The differentiated human ability to adapt an environment:

Is the thing that makes human beings interesting and unique, it’s not the genome. The genome is, of course, unique in the sense that only one species has this particular genome. But that’s not it. It’s what the genome has adapted to as well as potentiated that makes us interesting” (interview, 19 August 14).

Although this work is somewhat speculative, Kevin Laland intriguingly argues that niche construction is one force that has allowed for humans to differentiate themselves from other animals. He notes that, although many animals display an impressive level of intelligence, humans have developed technological abilities not present in other species and have been able to produce a diversity of things not known in other species. In other words, humans have a unique capacity for culture that the standard evolutionary theory on its own falls short in explaining. Laland supposes, like Sinha, that the ability to modify the environment has created a positive feedback loop whereby the modified environments humans produce has also played
a role in driving human development (Laland, 2017). Niche construction therefore (controversially) includes cultural factors (defined as shared “ideas, beliefs, values, knowledge”) as forces in evolution—as these factors will, no doubt, influence the type of niches humans might construct and therefore direct the development of the human species. Laland gives some specific examples of “culture” leading to the selection of particular genes in humans, for example selection for lactose tolerance in groups of humans that farm cattle, suggesting that the everyday labour of these humans is making itself felt in their genes (Feldman and Laland, 1996, p453) although this work is controversial.

This particular example might also prove uncomfortable for some of those radical biologists referred to in this thesis who have questioned the notion of genetic race. If “culture” can play a role in evolution, this suggests that cultural difference might lead to genetic differences between different human groups such as variations in their ability to tolerate lactose. But, as many have pointed out, there are in reality very few genetic differences between supposed human “races” (see El-Haj, 2007, pp283-286). Here Sinha’s clock example is interesting in that it does not require the selection of genes for clock use among people who have been influenced by the presence of clocks—clock use might influence behaviour and language in a group of individuals without the need for a gene “for” clock use that is inherited and selected for. Sinha’s example also of course does not require the separation of humans into the same traditional racial groups established by colonial powers from the 16th century onwards. He refers to the circumstances in which people live—in societies that use clocks versus those that don’t—rather than to putatively innate racial differences such as being black, white or Asian.

In February 2018, studies of the full genomes of several Neolithic farmers (including one referred to as “Cheddar man”) appeared to confirm Laland’s hypothesis by showing that people living 6,000 years ago in what is now the British Isles were indeed lactose intolerant as well as having relatively dark coloured skin, the latter fact being more widely circulated in media reports (Brace et al, 2018). This suggests that lactose tolerance developed as humans started to farm animals. Provided with relatively tolerable Holocene conditions, these early farmers were able actively to drive their own evolution and develop lactose tolerance by constructing a pastoral niche. Although these processes are common to non-human species, the Holocene seems to have marked a qualitative shift in the capacity for humans to create such niches and simultaneously to evolve as a species in this account.

Work such as this in niche construction therefore links the actions of humans at a local scale with the consequences of those actions, which manifest at a global scale in discussions of the Anthropocene. It is interesting to note then that two science writers, Margaret Lock and Gisli

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56 Laland does not mention Engels in his 2017 book but Sinha may be familiar with his writings.
Palsson perform a similar manoeuvre when describing how the Anthropocene changes common assumptions about biology. In *Can Science Resolve the Nature/Nurture Debate?* (2016) they explain how, having sequenced the human genome (in a project completed in 2003), scientists are discovering that the genome is more complex than just a code that gets “read off” to produce proteins. There are also a host of other “epigenetic” processes at work. For example, the expression of genes can be turned on or off by processes such as DNA methylation, and that this may, it is suggested, be influenced by a person’s lifestyle or environment (Lock and Palsson, 2016, pp41-45; Parrington, 2015, chapter 9). Lock and Palsson argue, with reference to Richard Lewontin’s work, that new insights into epigenetics are challenging the determinist view that the sequence of genes in the genome alone can tell us what makes us human. Rather than “causing” development, genes are “activated by other parts of the genome responding to signals external and internal to the organism and its cells. Networks of interacting proteins are widely understood as self-organised and not as part of a pre-coded programme” (Lock and Palsson, 2016, p36). Epigenetics therefore suggests that the “environment” in which organisms live can modify their gene expression in heritable ways.

All of this might seem far-removed from the concerns of environmental geography. However, for these authors, when discussing the “environment” in which a person lives and the possible influence this might have on how their genes are expressed, it is not sufficient to treat the “environment” as merely a person’s immediate surroundings. Lock and Palsson have therefore questioned dualist approaches to spatial scale, pointing to the mutual influence of processes at a global scale, those at the scale of the human body and those at intercellular level. The Anthropocene figures in this narrative as it “signals the collapse of this distinction between natural history and human history” such that human-initiated processes can no longer be easily differentiated from “natural” ones. Lock and Palsson might add that, in the Anthropocene, the environment that modifies gene expression is one that is itself modified by human activity. The socially produced environment that humans are exposed to is what Odling-Smee, Laland and Feldman (2003) might refer to as humans’ ecological inheritance. Lock and Palsson are consequently strongly opposed to the dualism inherent in trying to separate the biological body from the social body (2016, p55).

By contrast, refusing to acknowledge global-scale environmental change has resulted in a kind of miniaturisation of “the environment” for biologists. In discussions of epigenetics, this has contributed to an understanding that the environment of a foetus is only their most immediate surroundings, leading to an overemphasis on lifestyle (particularly the lifestyle choices of pregnant mothers and its effects on foetal health) at the expense of social justice concerns related to phenomena operating at wider scales such as, perhaps, toxins in drinking water and the social relations that give rise to them.
Several of the scientists discussed in this thesis similarly draw on themes of the manipulability of the biological or natural world. For example, John Parrington’s popular genetics books draw attention to the ways in which genomes, often treated as essential and fixed are also potentially modified, by the environment in the case of epigenetics (Parrington, 2015) and by human action in the case of genome editing (Parrington, 2016).

7.6: Conclusion

When applied to human evolution, niche construction intriguingly suggests that human action, including in this case conscious action in producing a particular environment, might influence evolution. Although processes of niche construction are common to all living things—the ability of earthworms to modify the composition of soil is significant—Laland and Sinha would argue that the feedback loops created by the specific ways in which humans have changed the environment have allowed for humans to differentiate themselves from other living things. Rather than treating the ability to modify the environment as innate to humans, the niche construction perspective suggests a more contingent process whereby human nature has developed in a relation with the environment in which humans and human societies have evolved and where humans are also part of their environments. It sees this capacity as itself arising through an evolutionary process. From an ecological Marxist point of view it is also the specific social form in which humans are organised—ie capitalism—that has created a qualitative shift in the relationship with the rest of the biosphere rather than this process being linear or gradual.

However, as Wilcox and Rutherford point out, despite humans’ differentiated ability to become historical actors, it is often forgotten that other animals also have a history. These authors would remind us that not only is historical analysis “important to animal geographies”, but that human subjects “are not the only beings capable of shaping the world” (Wilcox and Rutherford, 2018, pp2-3). It is further argued that perceiving animals as objects rather than subjects is related to their treatment as static or unchanging; to be considered active subjects it would also need to be recognised that animals shape the world in historically relevant ways such as, in the case of earthworms, by making changes to soil over time. The perception of animals as static is reinforced by cultural practices such as the ways in which animals are presented in natural history museums. Neglecting to historicise animals is one aspect of a human exceptionalism that treats them as part of a passive “nature” that serves as a background to human activity.

However, since Darwin established the theory of evolution by natural selection, biology has offered an alternative vision of living things, including animals, as dynamic rather than static, a
sensibility evident in his final book on earthworms. As Darwin argues, the activity of worms may be slow but over time it can have dramatic effects including contributing to soils that human society relies on for agriculture. For niche construction biologists, animals do not merely have histories, they also play a role in shaping history to the extent that they alter their surroundings including modifying selection pressures that drive their own evolution. Taking a historical approach to animal geography reminds us that humans do not manipulate a passive and malleable earth, we act on an earth that is already being continually churned by worms.

Recognising the difference in capacity to modify the environment between humans and other animals goes against the new materialist tendency to flatten agency such that human and non-human agencies are all the same. However, it does not follow that other species are not “historical” or that they have not played a constitutive role in the development of human societies. An approach that recognises the differentiated capacities of humans as opposed to other animals need not mean that humans are able to freely manipulate the rest of the biosphere according to their will.
Conclusion: Towards a dialectical political ecology

This thesis has argued throughout that the proposed designation of an Anthropocene epoch (see Bonneuil and Fressoz, 2017, pp3-4) will have transformative consequences for environmental theory. It looks increasingly likely that scientists will locate the start date of the epoch in the middle of the 20th century (Anthropocene Working Group, 2016). Such a recent start for the Anthropocene would make it unfeasible that the situation was caused by human activity per se; the new epoch must have arisen as a result of the influence of capitalism throughout the world. Therefore, the critiques of specifically capitalist socio-ecological relations outlined in chapter two of this thesis, although in many cases they predate discussions of the Anthropocene, are indispensable when it comes to making sense of it. Marx’s own work, although his writings on nature were incomplete, offer the basis on which to do this. In particular, as demonstrated in chapter two, the value theory developed in Capital and his writings on the metabolic relationship with nature have both been used productively by subsequent generations of ecological Marxists to develop an understanding of capitalist socio-natures today (see Burkett, 2014 and Huber, 2017 on value theory, Foster, 1999 on metabolism and Saito, 2017 on alienation).

Following Lorimer’s work (2012; 2015), it is further argued that the idea of the Anthropocene can be mobilised in order to build a more progressive political ecology. But, rather than naturalising the existing state of things, there is a widely recognised need to discuss how the Anthropocene came about. The new epoch calls for an approach to socio-natural relations that emphasises how these relations have changed through time; as biologists Levins and Lewontin have long argued (2006), there is a need to discuss what processes led to things becoming the way they are and how these processes might play out in the future. A theory adequate to the Anthropocene must therefore be both historical and political. It must be capable of capturing process, complexity and internal relations.

Such an approach should avoid reducing questions of human behaviour to issues of biology. As ecologist Ian Rappel, with reference to Richard Lewontin, points out, those thinkers who have seen environmental destruction as an inevitable outcome of “human nature” have often
taken such a reductionist approach, positing an external relationship between humans and nature rather than a dialectical one (Rappel, 2015, pp107-108). Murray Smith similarly guards against the dualism that sees human conscious activity as reducible either to the material or natural or to “ideas” distinct from concrete activity (Smith, 2009, pp376-378). This thesis has demonstrated how dialectical biologists including Levins and Lewontin and their peers have developed the type of non-reductionist methodology that is needed and how their work might inform a more ecologically engaged Marxism.

8.1: What kind of science for the Anthropocene?

The contributions of dialectical biologists are varied. Indeed, as Levins and Lewontin are understandably keen to point out, their dialectics is more a “habit of thought” (Levins and Lewontin, 1985, p267) than a list of rules to follow. Dialectics, for them, is a predilection towards looking for complexity, dynamism and agency in the biological world rather than a rigid series of laws that a biologist comes ready equipped with when they carry out their research. As Levins argues, part of Lysenko’s mistake was to try to work from philosophical principles to reach biological conclusions (Levins, 2007). Such an approach is dualist in itself as it suggests that scientists are detached from their object of study and simply approach it from the outside. If such a view of scientific practice was ever tenable, it is harder to justify if we fully accept the implications of the Anthropocene, whereby humans are transforming the biosphere in intensive as well as extensive ways.

However, despite the dialectical biologists’ reluctance to put forward a list of laws, some themes can be discerned from their work that are relevant to the debates outlined in the first half of this thesis. Firstly, understanding systems as existing in a state of flux has been central to the project of dialectical biology, as has accounting for processes that, rather than being “social” or “natural” are irrevocably socio-natural. Instead of assuming systems to be static unless an external force encounters them, dialectical thinkers assume systems to be dynamic and treat stasis as an aberration to be explained (Levins and Lewontin, 1985, p277). As well as Engels’ hints about “matter in motion”, such thinking echoes Bertell Ollman’s point that dialectics is a method for grasping the inherent dynamism of the world. Ollman even introduces his study of dialectics by comparing it to attempting to jump onto a moving car as opposed to one that is stationary; one needs a method of understanding how fast the car is moving and in what direction (Ollman, 2003, p11).

This is also one of the most expressly political aspects of dialectical thought as it recognises that the potential for change is always inherent in the conditions of the present. It is analogous to the way in which Marx analysed the dynamics of capitalism and the prospects for its future
development. With regards to environmental issues specifically, Neil Smith also criticises the persistent assumption that nature is external to human history, and consequently that the latter is universal and does not go through changes of its own (2008, pp11-12). As demonstrated in this thesis, this idea of an unchanging nature runs counter to much of thinking in biology, which has recognised the dynamism of ecosystems and where the creation of novel ecosystems by human activity is increasingly a focus of interest (Hobbs et al, 2006).

Secondly, dialectical biology is informed by materialism. In fact, many of the biologists referred to here are engaged in a critique of the type of idealistic thinking that sees the information contained in genes as the sole or primary causal factor in evolution. They have seen this tendency to explain complex systems by reference to their smallest and most stable units as symptomatic of the reductionism and genetic determinism common in biology and even suggested that reductionism is due to the influence of bourgeois individualism (Levins, 1981). Like the new materialists, some biologists have developed an approach that engages with the physical properties of material things such as those attributes that enable animal bodies to maintain their stability. For example, Stuart Newman has highlighted the way in which the properties of animal tissues impose constraints on the direction in which natural selection can drive the evolution of animal forms (Newman, 2007). Organisms cannot freely evolve in any direction in response to pressures from the environment like a ball rolled across a table; instead, trying to roll a polyhedron on a flat surface would be a more apt analogy (Clark and York, 2005a).

The insight that organisms do not passively respond to environmental influence is related to a more general turn towards recognising the active role of living things in evolution that has been promoted by Lewontin in particular (Lewontin, 2007, Levins and Lewontin, 1985). This emphasis on what might be described as a type of “agency” extended to non-human living things deserves to be seen as the foremost contribution of dialectical biology. The theory of niche construction, influenced by Lewontin, is changing how biologists think about evolution with its striking conclusion that organisms drive their own evolution by exposing themselves to different selection pressures. The theory has also been taken up by ecologists who have questioned the assumption that ecosystems have a fixed carrying capacity—with its implications for human population—given that organisms construct their niche rather than simply adapting to fit a pre-existing mould (Vandermeer, 2008). Niche construction has also been utilised by political ecologists to challenge adaptationist thinking, for example the assumption that populations (of humans) act in order to adapt to fluctuations in their environments (Watts, 2015).

Theories that take account of niche construction introduce some complexity into how theorists might conceptualise organism and environment. The theory makes it inadequate simply to state
that organism influences environment and vice versa in an external relation. It also requires an
acknowledgement that the environment effectively does not exist prior to the organism that
inhabits it (Levins and Lewontin, 2007, p34). However, its advocates do not say that the
distinction between organism and environment is dissolved completely in favour of seeing
them together as an “organism-environment complex”. John Vandermeer (quoted in chapter
cfive) refers instead to a dynamic and mutually creative relationship.

Brandon and Antonovics (1996, p174) concur that the theory cannot be understood
atemporally. In other words, if organism and environment are assumed to both be static it is
possible to consider them as separate entities, but when the way each transforms the other
through time is taken into account, organism and environment come to be seen as cause and
effect of each other. This seems to accord with the point Braun makes in his critique of new
materialism’s engagement with biology. Braun argues that the organism cannot simply be seen
as the outcome of a complex of relations; it must also itself maintain some kind of stability and
efficacy in order to have a constructive effect on the environment (Braun, 2006, pp209-210).
This view also forms the basis of a Marxist interpretation of human nature, as it is strikingly
similar to Marx’s complex and contradictory view of human nature as having an “essence”
which, at the same time, is also the ensemble of social relations (see chapter seven).

Thirdly, dialectical biologists have integrated understandings from the social and natural
sciences to develop an approach that, drawing on the previous points, assumes that socio-
natural systems are dynamic rather than static and accounts for the agency of living things
within those systems. Ivette Perfecto and John Vandermeer have done much to develop this
approach and apply it to real-world agricultural contexts. The contributions of these ecologists
to this field are multiple and are only briefly summarised here. They have highlighted the way
in which the human creation of new ecosystems can, rather than simply being a threat to
nature, actually in some cases enable other species to flourish. They have referred to the
functional capacities of various species living in coffee plantations, particularly as sources of
autonomous pest control in agriculture (Vandermeer, Perfecto and Philpott, 2010). In this they
have come to conclusions similar to those reached by Lorimer in his (2015) study of the way
rewilding makes use of the activities of animals like the Heck cattle introduced to the
Oostvaardersplassen to recreate the grazing processes of their extinct relatives. And these
dialectical biologists have extended Levins’ work on metapopulations to show how species of
organism often exist in patches within a matrix and argued that conservationists ought to take
account of the ways in which organisms migrate between patches of suitable habitat rather
than treating each patch as separate (Perfecto and Vandermeer, 2002; 2008).

Perfecto and Vandermeer have also shown how socio-natural systems often display a
distinctive temporal dynamic; they might exist in one state for some time until some influence
forces them to switch to a qualitatively different state rather than there being a smooth and gradual transition, with intermediate stages, from one syndrome of production to another. Drawing on their expertise in coffee agriculture, with the case of transitions between sun coffee and shade coffee regimes, these biologists have illustrated mathematically how systems can shift from one state to another (Vandermeer and Perfecto, 2012).

The final point here about coffee regimes being characterised by abrupt shifts between states is particularly relevant to discussions of the Anthropocene as human action is one such influence that could lead socio-natural systems to reach tipping points and suddenly and unexpectedly shift from one state to another. Indeed, the Anthropocene itself could be seen as an example of a rapid shift in socio-natural relations on a global scale taking place (perhaps) in the middle of the 20th century. Discussions of the Anthropocene have demonstrated the need for a theory that not only historicises socio-natural relations but also recognises that quantitative change can become qualitative. As Clark, Foster and York point out with regards to the relationship between Marxism and evolutionary theory: “A key feature of the Marxist view of history is that change is not typically smooth and continuous, but rather, often occurs very rapidly following periods of stasis” (Clark, Foster and York, 2007, p538). In an example that Perfecto and Vandermeer are familiar with, pest outbreaks are often characterised by the pest population remaining low for some time interspersed with periods of rapid population growth, often as a result of the interactions between the species of interest and its predators or symbionts. This emphasis is exemplified by the dialectical approach expressed in Gould and Eldredge’s theory of punctuated equilibria in palaeontology as well as Perfecto and Vandermeer’s work. The following points therefore summarise the key ways in which the dialectical approach outlined in this thesis differs from what might be called “mainstream biology”:

- Dynamism is assumed, it is stasis that requires explanation.
- Historical understanding of time that emphasises development rather than reversible change.
- Change is often understood as rapid, interspersed with periods of stasis, rather than gradual.
- Parts cannot be understood without reference to the whole, abstraction needed as a method in order to focus on some elements of a totality at any one point.
- Genes are important but there is a need to understand their operation in the context of the organism as a totality.
- Focus on the material properties of DNA and other aspects of biological systems.
- Ecosystems are constantly changing, never in their final state.
- Organism and environment mutually construct one another.
- Organisms play an active role in seeking, defining and modifying their environment.
- Processes of niche construction or environmental modification influence evolution as an organism’s offspring (as well as other organisms in an ecosystem) are exposed to the effects of this process.
- Carrying capacities of ecosystems are not fixed and do not simply apply an external pressure to organisms.

As this thesis has dealt with the contributions of a group of biologists who are influenced by Marxism, it has inevitably addressed the issue of the way in which scientists carry out their work and the attitude social scientists might take to ideas from biology. Science is often assumed to involve neutral practitioners observing processes within a system of which they are not part. As explained in chapter two, this seems to have been the assumption of Georg Lukács, for whom there can be no dialectics of nature as this would simply involve witnessing the unfolding of a series of laws in an external nature. Lukács’ view has now been refuted by many (Burkett, 2013) and the dialectical biologists have demonstrated through their practice that it is possible for scientists to be engaged in their subject of study while also recognising the role of human influence in apparently “natural” environments. For example, Perfecto and Vandermeer are both political in the sense of openly expressing an opinion about the phenomena they are studying, driven by their preference for organic agriculture managed by small farmers, and they have also sought out examples of agro-ecosystems where they can study the interrelated influence of human actions and those of other species. The Anthropocene, as mentioned above, also emphasises the impossibility of treating nature as distinct from society. Furthermore, the theory of niche construction has demonstrated that, contra Lukács, the subject-object dialectic is indeed present in “nature”; it is not unique to humans but might actually play a role in the evolution of species in general.

Levins, Lewontin and other dialectical thinkers have developed a distinctive approach to the philosophy of science. Key to this has been a critique, developed by activists, of the notion that science is neutral. But these thinkers also differentiate themselves from those social scientists who reduce science to ideology, unrelated to any truth about the real world. As discussed in chapter five, by stating that science is “class science”, that nevertheless tells us “real truths about the world” (Levins, 1981, Sur, 2008), Levins in particular has emphasised the irresolvable internal contradictions driving science. These contradictions mean that science can progress as new knowledge is added but can also be held back as determinist and reductionist assumptions limit scientists’ ability to make sense of the new information generated.

The view of science as contradictory has meant that discussions of science for these thinkers can involve debates about its content—which scientific findings are right or wrong—as well as addressing matters of ideology such as the ways in which science under capitalism serves a
particular purpose (although of course as activists they have done much to address the latter). Without recognising this contradictory dynamic, it would be impossible for dialectical biologists to carry out their work. If they saw statements about the content of science as simply expressing the class position of the scientist they would presumably be able to deduce scientific knowledge from their own philosophical principles, imposing a proletarian science in place of bourgeois science (as was attempted so disastrously in the Soviet Union). Therefore it is possible to discern an approach to scientific practice based on that developed by Richard Levins and Science for the People and on critical approaches to the Anthropocene. Such an agenda might be summarised as follows:

- Subject and object are internally related.
- Scientists are part of and also modifiers of nature.
- Science is a social activity that produces a profit like other forms of work.
- Scientists should be open about their political views. Knowledge, including scientific knowledge, is unavoidably biased.
- Science finds out truths about the world.
- The class basis and truth of science present an unresolvable contradiction.

It should, of course, not be surprising that the ideas of Levins and Lewontin and other dialectical biologists support a Marxist view of society, nature and human nature. They have read Marx and Engels’ work themselves and are influenced by it. For example it is no coincidence that Sinha’s work on human evolution and language bears some resemblance to Engels’ comments on human evolution in *Dialectics of Nature* (see chapter seven). Admittedly, this runs the risk of creating a circular argument, where Marxist ideas influence biology which in turn provides a basis for confirming the validity of the Marxist view. Indeed, once it is recognised that science is not neutral, it is no longer feasible to use ideas from science as a basis on which to justify one way of thinking or another.

However, although many of the biologists interviewed here would argue that their mind was prepared to see things in a particular way due to their philosophical background, having a philosophical outlook is no substitute for doing the painstaking work of collecting data and carrying out experiments in the lab or field that they have built their careers on. They might also point out that all scientists have a philosophy; not just Marxists. Darwin was influenced by liberal, Malthusian ideas in developing his theory of natural selection and his work was later used to justify these same ideas. This does not mean that Darwin’s ideas are false, merely that we ought to recognise that he was influenced by the prevailing ideas of his day. Therefore, were dialectical biologists to refrain from putting forward their own interpretation within
debates about biology, it would only leave the field dominated by conservative or bourgeois interpretations.

8.2: What kind of politics?
The contribution of dialectical thinkers to debates among biologists and sociologists of science is interesting in its own right. However, this thesis has aimed to use their ideas to engage productively with two debates; that between ecological Marxists and theorists in the new/vital materialist tradition and another debate among Marxists about the nature of a dialectics of nature. For example, there have been arguments between metabolic rift theorists and advocates of a world-ecology approach with the latter accusing the former of soft dualism and the former responding by defending an account of society and nature as a differentiated unity.

Perhaps the key contribution of ecological Marxism has been in politicising the Anthropocene and uncovering the capitalist social relations at the root of many of the environmental problems associated with it. In some ways therefore it is understandable that Marxists would want to centre their analysis on human activity in developing a critique of the specifically capitalist production of nature. As Smith argues: “There can be no apology for the anthropomorphism of this perspective: with the development of capitalism, human society has put itself at the centre of nature, and we shall be able to deal with the problems this has created only if we first recognise the reality” (Smith, 2008, p8).

However, some have been dissatisfied with Marxist accounts that seem to foreground human agency while paying little attention to the actions of non-human species. Marxists have therefore been accused of anthropocentrism (see for example, Bennett, 2010, p.xvi). Anthropocentrism can end up treating the non-human world as freely manipulable by human action. If nature is treated as merely “brute matter” it is cautioned that it may become seen as the backdrop against which politics plays out (Hinchliffe, 2008) or, worse, as simply a resource there to be appropriated for human use (Braun, 2011).

Somewhat counterintuitively then, in discussions of the Anthropocene epoch where it might be expected that narratives that centre on human activity would predominate, new or vital materialist approaches have become common within geography and cognate disciplines. These theoretical trends are characterised by their tendency to expand the notion of agency well beyond seeing it as a possession of the human subject (see Braun, 2009; 2015). As well as their engagement with non-human agency, new/vital materialists are interested in the properties of things and the processes that crystallise into things at particular moments. By refusing to divide the world into lively humans and inert matter they have developed an approach that,
from the outset, resists dualist interpretations that start from society and nature as two separate poles.

As explained in chapter three, new materialist accounts have been met with their own criticisms. These theories have been described as “politically inert”, with their advocates reluctant to make normative judgements (Kirsch and Mitchell, 2004, pp694-695). Indeed, in these narratives there is often a lack of attention to the directedness of social relations—and the processes by which humans might gain power over each other or over non-humans. Some have drawn fairly conservative conclusions about the political action needed to approach some of the environmental problems they highlight, in some cases offering little other than an inducement to be more open to the capacities and performances of the things of the world.

However, despite their limitations, these theories do offer a genuine challenge for Marxists. Some have responded to this challenge with calls to develop a “dialectical naturalism” (see Brincat and Gerber, 2015, p887) that denies the separation between humanity and nature. As explained in chapter two, misgivings about the tendency in some accounts to ignore non-human agency have also been raised by those sympathetic to Marxism. For example, Jason Moore, although critical of new materialist flat ontologies, has identified a need for a political approach that attends to the specifics of non-human processes rather than just seeing non-human nature as wholly absorbed into capitalism (Moore, 2017b, p299).

Contra the accusations of some of the new materialists, there have always been interpretations of Marx’s ecology that have always avoided crudely establishing society and nature as two separate poles that come to relate. For example, Smith is less interested in understanding how society and nature relate and more concerned with a dialectical interpretation of the processes that have led to them becoming separated. For Smith, such a method “begins with the relation with nature as a unity and derives as a simultaneously historical and logical result whatever separation between them exists” (Smith, 2008, p48). In pursuing this approach, Smith follows Marx and Engels, whose starting point in their early work is that humans are part of nature, and who therefore develop a complex understanding of how humans oppose themselves to nature through the labour process (see Murray Smith’s 2009 article “Against Dualism” and also chapter two).

As Burkett adds, Marx himself also refers to the ways in which processes outside of the direct control of humans contribute to wealth or use value (if not the specific form of value that is produced solely by exploited workers in a capitalist system). For example, Marx explains how in wine production the wine needs to be left alone for the yeast to produce alcohol: this process is, to some extent, outside of human control (the capitalist may wish to speed this up in order to increase their profits relative to their rivals but there are limits to how much they can do so).
Here the need to leave the wine for a period of time causes an interruption in the labour process; although the activities of the yeast are part of production, these activities are not themselves understood as labour (Burkett, 2014, pp43-44). However, the intention of this thesis is not to recount the references to non-human activity in Marx’s own writings. Instead, following Harvey’s maxim that “the only way to understand [Marx’s] method is by following his practice” (Harvey, 1996, p48), it has pursued the project of understanding how a group of Marxists have utilised his dialectical methods in practice in their own discipline of biology.

Some Marxist theorists, notably Andreas Malm, have responded to the challenge posed by new materialisms by retreating into a defence of dualism. Contra not just the new materialists but much of contemporary environmental geography, Malm sees an issue like air pollution as best understood by treating society as expelling its waste into an external nature (Malm, 2018, p178): nature really is something that develops separately from human activity. Tellingly, he repeatedly uses the example of British imperialists coming across a coal seam on the island of Labuan near Borneo to illustrate his understanding of nature as something that predominantly exists prior to human action and is “encountered” by humans rather than produced or constructed (Malm, 2018, p42).

Far from defending this distinction between society and nature, this thesis has demonstrated, with the work of the dialectical biologists, that it is possible to develop a Marxist approach that takes seriously the material properties of the non-human world and the agential capacities of non-humans. Indeed, this project is central to the approach to biology developed by Levins and Lewontin and other dialectical thinkers. However, such a project is also compatible with one that acknowledges the role of humans in producing socio-natures in historically and geographically specific ways.

The dialectical biologists are often mentioned approvingly by social scientists. As chapter two has shown, debates over the dialectics of nature have re-emerged among Marxists in recent years. And theorists on all sides are keen to claim Levins and Lewontin as their own (see, for example, the references to their work in that of the metabolic rift theorists Clark and York, 2005a and 2005b and in Moore’s book, 2015, p46). Malm refers to Levins and Lewontin briefly to assert that conscious planning is unique to humans and to argue against a holism that simply states that everything is connected (2018, pp87 and 182). Here, this thesis is in agreement with Malm on both these specific points. However, Levins and Lewontin’s contributions in general do not support his views.

The work of dialectical biologists, instead of emphasising disunity between social and natural processes, has drawn attention to the impossibility of separating the two. Levins and Lewontin refer to Ollman in their work (Levins and Lewontin, 2007, p186) and are evidently influenced
by his philosophy of internal relations in several aspects of their thinking, including, for example, their understanding of dynamism as inherent to socio-natural processes rather than such systems being animated by an external force. The striking statement “the environment does not exist” is not the hubristic assertion of an idealist thinker but is, of course, a quote from Richard Lewontin that appears in several of his works (Levins and Lewontin, 2007, p34; Lewontin, 2001) and that, it can only be assumed, he stands by. Therefore, if ecological Marxists are consistent in calling for a dialectics of nature—and Levins and Lewontin are the closest that can be found to a real-world example of a dialectics of nature—this is an aspect of their thought that ought not to be overlooked. And, as evidenced at some length in this thesis, it would be remiss to ignore or discount theories of the agency of non-humans. Although humans have a differentiated capacity to modify the environment compared to other species, the actions of ants, earthworms, beavers, cattle, bacteria and multiple other species produce their own spectacular transformations and relate in complex ways to the niches created by humans.

In conclusion, it is an interesting time to be discussing Marx and nature. The multiple and emerging environmental problems highlighted daily in the media make this an urgent task. It is argued here that theorists ought to engage with debates about the Anthropocene despite the fact that there are many interpretations of the Anthropocene that critical geographers will find problematic. For one thing, for the scientists currently considering the Anthropocene there is substantial evidence for the epochal shift it signifies. This thesis has developed a critical approach to scientific knowledge and has questioned the assumption that scientists have unmediated access to a singular and stable nature. Nevertheless, the intention here is not to deny the reality of the rising global temperatures, increasing amounts of plastic in the oceans, declines in biodiversity and a whole range of other alarming signals of global biospheric instability. But the lively discussions among Marxists show that the environment and wildlife are no longer seen as outside of the concerns of socialists. These altercations will no doubt continue and the input of biologists will not settle them conclusively. However, it is hoped that this thesis will contribute in some way to the kind of theory required to make sense of socio-natures today.
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