



LUND UNIVERSITY

Participation in evolution and sustainability

Clark, Thomas; Clark, Eric

Published in:
Transactions of the Institute of British Geographers

DOI:
[10.1111/j.1475-5661.2011.00492.x](https://doi.org/10.1111/j.1475-5661.2011.00492.x)

2012

[Link to publication](#)

Citation for published version (APA):
Clark, T., & Clark, E. (2012). Participation in evolution and sustainability. *Transactions of the Institute of British Geographers*, 37(4), 563-577. <https://doi.org/10.1111/j.1475-5661.2011.00492.x>

Total number of authors:
2

General rights

Unless other specific re-use rights are stated the following general rights apply:
Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

Read more about Creative commons licenses: <https://creativecommons.org/licenses/>

Take down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

LUND UNIVERSITY

PO Box 117
221 00 Lund
+46 46-222 00 00

Participation in evolution and sustainability

Clark, T. L. and Clark, E. 2012 Participation in evolution and sustainability,
Transactions of the Institute of British Geographers 37 (in press)

Thomas L. Clark Psychologist
1515 Payne St
Tallahassee FL
33203
USA
thomas.lyon.clark@gmail.com

and

Eric Clark Lund University, Department of Human Geography, and
Lund University Centre of Excellence for Integration of
Social and Natural Dimensions of Sustainability (LUCID)
Sölvegatan 10
22362 Lund
SWEDEN
eric.clark@keg.lu.se

Participation in evolution and sustainability

Abstract:

The modern synthesis of genetics with evolution slanted our understanding of evolution and of ourselves by rejecting Darwin's view of animals as participating in their own evolution. Defining evolution in terms of genetics, the modern synthesis indulges excessive individualism and distorted self-images as self-made. At the same time such gene-centered thought, evoking images of master molecules making us who we are, hollows out volition and so also moral concerns and political alternatives. Drawing on the geography of thought, we argue that stubbornly tacit preformationist biological thought reflects and anchors social processes that limit adaptability in reaching toward sustainable living. We appeal for leveraging sustainability efforts by affirming in theory and in the public square an open image of human nature that recognises the participation of our ancestors in becoming who we are, obliging people to make their history together. Achieving the collective self-regulation sustainability requires may depend on correcting slanted reasoning about ourselves.

Keywords: evolutionary biology, human geography, human nature, participation, sustainability

Such a view ... poses a severe threat to humankind because it links the authority of science with an imagery of the human condition that can only trivialize and obfuscate its beneficiaries.

Sigmund Koch (1981, 266)

[A] perverse and mistaken idea of human nature ... endangers our existence.

Marshall Sahlins (2008, 112)

Introduction

In his appeal for a more open image of humanity Kenneth Bock recalled Circe magically turning Ulysses' men into animals, lifting from their shoulders the more acute self-consciousness and moral challenges of being human. In a turn of Homer's original plot, Gelli (1549) required Ulysses to convince his men to choose becoming human again, but his arguments 'about the refinements of human life and the superiority of human understanding or intellect carry little weight against rejoinders concerning the dire results of people's incontinent indulgence in luxury and the absurdities into which they have been led by their finely honed but tortuous reasoning' (Bock 1994, 17).

This variation on a Western canon rouses perennial tensions at the boundary of social theory and biology. What is human nature? How are humans similar to and different from each other and other animals and what does this tell us about ourselves? How has reasoning been twisted, toward what ends, in

framing and answering these questions? How do our answers reflect and affect our indulgences and prospects for achieving the collective self-regulation sustainability requires?

Taking up these questions and drawing on geographies of thought and boundary crossings, we argue that stubbornly tacit preformationist biological thought reflects and anchors social processes that limit adaptability in reaching toward sustainable living. These implications for sustainability underscore the importance of human geography's engagement with contemporary life sciences (Castree 2009) and the urgent need for 'conversation about our "species being"' (Harvey 2000, 207).

Participating in evolution

With varying degrees of emphasis Darwin recognized behaviour, use and disuse, as a causal factor in evolution. In Darwin's view (1964 [1859], 134-36), insects' use or disuse of their wings on windswept islands, where they are 'frequently blown to sea and perish', were part of the natural selection of enlarged or reduced wing sizes in successful fliers and successful if 'indolent' walkers, respectively. The ostrich's defensive use of its legs and disuse of its wings played some part in the selection of a large, flightless bird. For Darwin, insects and ostriches participated in their own evolution.

In *On the Origin of Species*, Darwin (1964 [1859], 134-137, 143, 206, 447, 479) invoked use and disuse in 'long-continued' time frames, not one generation to the next, and as 'quite compatible with', 'aided by', 'aiding' or

‘largely combined with, and sometimes overmastered by’ natural selection. And he consistently used the term “acquired” with reference to species, not individuals, across longer time frames, not one generation to the next, and often with explicit reference to selection processes. Yet Huxley (1960, 14, 20) and other prominent contributors to the modern synthesis considered Darwin’s references to use and disuse ‘Lamarckian errors’, chalked up to 19th century ignorance of genetics. They presented use and disuse as an alternative to ‘blind’ and ‘automatic’ natural selection, not as part of the selection process.¹ Evaluated only in terms of direct genetic inheritance, one generation to the next, of “acquired characteristics”, adaptations within the lives of animals were ‘rendered obsolete’ in evolutionary theory and ‘exposed ... as sins against Occum’s razor’ (Lerner 1959, 173).

Why this skewed reading of Darwin that minimised behaviour’s role in evolution? A good start at answering this question would note Darwin’s invoking use and disuse both as sources of variation and as influencing selection outcomes. A full answer would also recognize that the theoretical refinements of the modern synthesis were not simply hard science prevailing over soft folk wisdom. One aspect of folk biology, essentialist preformationism (we are born with something inside us that makes us who we are), superseded another, use and disuse (manners maketh the man). Nature as transmitted, context independent, centralized genetic program causing development eclipsed nature as constructed, context dependent, causally diffuse, phenotypic product of development (Oyama 2000a). The flip side of 19th century ignorance of

genetics was 20th century indulgence in excessive causal attributions to internal, stable characters: genes.

Focused on integrating genetics with evolution, the modern synthesis cast behaviour more as consequence than cause of evolutionary change. Intention in the lives of animals was dismissed partly on the coattails of arguments regarding superagents in evolution, God or a watchmaker with vision. Mayr (1961, 1504) rejected all purpose as ‘singularly inapplicable to evolutionary change ... If an organism is well adapted, ... this is not due to any purpose of its ancestors or of an outside agency, such as “Nature” or “God”.’ This conflation of ancestral intention with externally directed evolution eased biology’s robust rejection of purpose in theory, even as the practical language of biology remained thick with purpose.² Hence, Haldane’s quip that ‘Teleology is like a mistress to a biologist: he cannot live without her but he’s unwilling to be seen with her in public’ (quoted in Hull 1982, 298).

Evolutionary biology continues to present us with genes inside and an environment outside, which “interact” to produce an organism and its behaviour. A recent summary of evolutionary thought presents behaviour as evolving ‘just as morphological characteristics do’. Though neuro-developmental processes afford behaviour far more plasticity than anatomy and render behaviour less dependent on genetic mutations or recombinations presenting natural selection with different options, behaviour and morphology are treated similarly, as objects of evolutionary study explained by ‘genetic change, influenced by environmental circumstances’ (Meagher and Futuyma

2001, 3, 26). The scientific claim of computing an organism from its DNA is considered naïve not in principle, but for lack ‘even at present’ of an ‘instruction manual’, which awaits ‘improving technologies’ by which ‘genes that underlie behavioural variation will become increasingly easy to identify’ (Hoekstra 2010, 638-47).

Behaviour’s role has been shoe-horned into the internal (e.g., gene flow, Duckworth 2009) or external (e.g., niche, Lewontin and Levins 2007) side of this dualism or both, as “gene-environment interactions”. Innovative animal behaviours are called ‘evolutionary strategies’ (MacArthur and Wilson 1967, 6) or ‘evolutionary inventions’ (Grant 1998, 313), dodging the specter of intention while using the language of intention.

This bashfulness about behaviour reflects a causal privileging of genes and environments over the competent participation of organisms in their own development and evolution. Biological thought has long relied on tacit appreciation of this competence while explicitly minimising or neglecting it. Oyama (2000b, 336) describes several ways reasoning has been bent to this end by the intuitive appeal of a ‘homunculoid gene’. Traits are called “innate” or “acquired” based on analysis of variance, which is not the same as analysis of organisms (Lewontin 1974). While interacting only with other intracellular molecules, genes are said to “interact” with culture, humans being products of this “interaction”, not semiautonomous participants mediating and to some extent shaping it. Both similarities and differences across species are interpreted as indicating innateness, incest avoidance considered innate in humans because

it is seen in other animals, language considered innate because it is not. To Oyama's list, we would add the common misapprehension that genetic causes of disease reflect the degree to which genes specify health. In biology, agency is more comfortably ascribed at the scale of genes than of organisms.³

This causal privileging has been challenged repeatedly over the years. Gullick (1905, iv) observed that 'members of the same species, exposed to the same environment in isolated groups, will often arrive at different methods of dealing with the environment, and so subject themselves to divergent forms of selection'. Waddington (1960, 401) included the formulations 'animal chooses' and 'modifies environmental niche' as part of the evolutionary system. Ewer (1960, 162) noted that biology's 'reaction against teleology...went too far' in concluding, from the inability of animals' activities to be directly inherited, that these activities are irrelevant to evolution. Piaget (1971, 81) embraced biologists like Waddington for making evolution depend in part on development, 'and not only the inverse'.

Recognizing complexity, these scientists avoided the rhetorical trap Taylor (1998) calls simpling – reducing complexity to a manageable size for convenience, subsequent claims being inflated by confusing heuristic simplicity with valid generalization, confusing reductionism as method with reductionism as explanation, and convenience amnesia. Simpling is deceptively subtle when overextending otherwise sound concepts, such as "reaction norm", which refers to phenotypic variation of identical genes across different individuals in different environments. Though this concept reveals limits on genetic control of

phenotypes, it has been routinely invoked to assert genetic explanation of any given variation, favouring overgeneralization from the reasonable proposition of partial genetic and environmental regulation of phenotypes to the sufficiency of genes and environments to explain any particular phenotypic feature, including behaviour (Sarkar 1999). Turning a blind eye to the participation of whole organisms in their own development and evolution is not parsimonious; it is simpling, after which much progress in science is filling in gaps of its own making.

With genes, environments and chance in the driver seat, organisms are to be explained and not heard. Though zebra finch singing induces gene expression (Jarvis *et al.* 1998), Clayton *et al.*'s (2009) model integrating songbird genomes, brains and behaviour recognizes bidirectional causation between physiology and genome but not between behaviour and physiology. This omission reflects the cognitive activity of biologists, not the lives of songbirds.

Yet this model does recognize behaviour's role in natural selection, otherwise 'largely unacknowledged in current evolutionary theory' (Duckworth 2009, 514)⁴. Duckworth helps fill this gap by clarifying that behaviour can influence natural selection if it occurs in a large enough subset of the population and persists across several generations. Capacities for learning and cultural transmission subserved by a 'robustly epigenetic' mammalian brain (Goodenough and Deacon 2003, 806) expand significantly the means by which behaviour changes can pass these thresholds to influence selection.

Neglect of organisms' evolutionary effectiveness extends from academia to public lectures, museums and popular books, feeding back into our folk biology. In a recent lecture, Leakey (2010) referenced his personal commitments and described elephants coming to the aid of a different species attacked by lions, yet consideration of elephant or human volition in evolution was out of bounds. Asked about the current status of Waddington's inclusion of animal choices in modeling evolution, Leakey was 'dismissive' and recited the scientific creed that chance alone is sufficient, with natural laws, to account for evolution.

The Smithsonian Institution's David H. Koch Hall of Human Origins celebrates human inventiveness while presenting it more as a product – of 'environmental change', 'large, complex brains' and an evolutionary process defined by genetics – than as a causal force in human evolution (Potts and Sloan 2010, 53, 77, 168). Only obliquely intimated is the possibility that adaptive cultural innovations shaped human evolution by their incidental effects on selection pressures and outcomes, for example cooked food changing selection trade-offs for larger brains and smaller guts (Wrangham 2009) or hunting weapons leveling male hierarchies and reducing sexual dimorphism (Boehm 1999).

In his popular book, *Evolution for Everyone*, Wilson (2007, 159) misrepresents Boehm (1999) as showing that 'egalitarianism is not a cultural invention that began in ancient Greece, as many have supposed, but is part of our genetic endowment'. Implicitly equating ancient Greece with culture and

deeper prehistory with ‘genetic endowment’, Wilson minimises the role of moral sanctioning in creating and maintaining egalitarian dispositions. Boehm emphasises that humans invented egalitarian politics by intentional, indeed vigilant, cultural practices, creating ‘a major social-structural divergence at the level of the phenotype’ (Boehm and Flack 2010, 76). There is good reason to expect modest genetic contribution to such complex behaviour, which would anyway be as much consequence as cause, actions harnessing genetic variation, sometimes toward conscious ends (Boehm 2008).

This theoretical bias against organisms as participants in their own evolution has been shaped in part by biologists’ denial of their own participation in understanding life.

‘The achievements which form the subject matter of biology can be identified only by a kind of appraisal which requires a higher degree of participation by the observer in his subject matter than can be mediated by the tests of physics and chemistry. The current ideal of “scientificity” which would refuse such participation would indeed destroy biology but for the wise neglect of consistency on the part of its supporters’ (Polanyi 1957, 482).⁵

Also biasing theory against recognizing participation in evolution have been practical and conceptual difficulties in studying behaviour, genes providing more convenient “handles” (Gannett 1999); confusing science’s pragmatic exclusion of purpose with the conclusion that purpose is not real,

‘limit[ing] a problem by reason of a method of attack’ (Whitehead 1962, 15); confusing the historical priority of genes with their current domination of organisms (Gould 2001); a folk biology that favours homuncloid genes (Bateson and Mameli 2007); prestige processes within the culture of science (Burkhardt 1970; Fracchia and Lewontin 1999) ; and political-economic interests in controlling populations and sowing division with biologically essentialist thought (Kearns 2010; Nally 2011). These among other leanings elevated ‘one aspect of evolution to its very definition’ (Oyama 2000a, 12).

Crossing boundaries

Transitions across boundaries underscore the role of animal behaviour in evolution. Evolutionary changes commonly attributed to changing environments, including changes associated with colonisation and understood as “ecological release”, are often initiated and mediated by animals’ activities. Innovative foraging behaviours are major determinants of successful colonisation of novel environments (Sol *et al.* 2002; 2005a), granting some birds the power to stay, while others are obliged to migrate (Sol *et al.* 2005b). This is one way behaviour drives speciation and may explain why behavioural flexibility is associated with higher rates of speciation (Sol *et al.* 2005c).

Colonisation events reveal the participation of organisms in changing their environments and consequent changes in behaviour and morphology. Conspicuously but not uniquely on islands, whose significance here stems more from their boundaries than their isolation (Greenhough 2006), these

biogeographical processes indicate that behaviour ‘may be a potent force in driving evolution in novel directions’, while sometimes actually reducing the likelihood of genetic change (Price *et al.* 2003, 1433)⁶.

Price (2008) notes social transmission of innovation in some birds and innovates himself in emphasizing behaviour and development alongside ecology and genetics. The Grants (2008) also feature behaviour more prominently as causes of speciation among Galapagos finches. Attention to boundary crossings contributed to this constructive redirection in thinking about speciation, which had ‘tended to overemphasise genetics at the expense of ... behaviour’ (Owens 2008, 185).

Human colonisation also depends on behavioural flexibility. John Terrell (1986) described such flexibility in the settlement of Pacific islands, seen in tolerance for diversity of thought, intensive sharing that was by geographic necessity also quite extensive, and remarkable navigational skills. Without benefit of sextant and meeting the demanding requirements of dead reckoning, Polynesian wayfinders routinely navigated many miles of open sea. Such ingenuity in the service of perpetual sharing allowed humans to cope with the harsh biogeographic contingencies of small numbers on small islands, known to impose high rates of extinction.

Having changed their environment toward a more continental abundance and connectedness, ‘it demands no impossible leap of imagination to view all of Polynesia as just another Melanesian village’ (Terrell 1986, 261). Socially focused and socially mediated mobility (Warf 2008) is part of a broader

adaptability by which humans made geographic boundaries more permeable, deferring the usual biological constraints on island dominants while rendering islandness less distinctive in human geography (Cliff *et al.* 2000).

Geography of biological thought

The geography of thought casts light on evolutionary theory's entanglement in social issues. Compared with East Asians, Westerners attend more to actors than context, attribute more causal significance to fixed internal characteristics of categorized objects, make more causal attributions even while seeing fewer factors as relevant to understanding the world (Nisbett 2003), and recognize individual agency more than group agency (Kashima *et al.* 2005; Haslam *et al.* 2006). Causal theories and focus of attention reinforcing each other (Plaks *et al.* 2001), Western habits of thought arrive comfortably to a view of social, political and economic processes as driven by internal, stable, biologically “endowed” dispositions of individuals. Hence, twentieth century biology in the West ‘witnessed a general trend to emphasize the constancy and causal efficacy of the genotype at the expense of the complexity of its interactions’ (Sarkar 2006, 80-81). Less inclined to individualism, reductionism and human-animal dualism, the East, particularly Japan, readily accepted evolution including attribution of intentions to animals and pragmatic anthropomorphising, to the advantage of Japanese primatology (de Waal 2001a).

‘Culture seeps into science unbidden’ (de Waal 2001b 46), the study of behaviour being particularly vulnerable to cultural bias. Compared with

Western science, Asian scientists have paid little attention to individual differences in stereotyping or prejudice (Fiske 2000). More consequential examples include the shadows power relations and nationalism cast over scientific conceptions of race (Blakey 1998; Templeton 1998) and prehistoric archeology (Richards 2003).

Essentialist individualism finds expression in both scientific and lay theories (Keller 2005; Levy *et al.* 2006), between which reciprocal influences played out historically as Darwinian evolution's conceptual consistencies with capitalism brought it wider acceptance. Livingstone (2003) sketches this geography, regional differences in receptiveness to Darwinism varying with religious commitments, racial politics and economic interests. For example, Darwinism was embraced in New Zealand as a ready justification for routing the Maori. Russia, lacking a market based middle class, favoured cooperation and rejected Malthusian elements of Darwinian theory. Kropotkin and other Russian critics recognized that 'contrary enthusiasms' regarding Darwin 'might record the parochiality of his different surroundings' (Gould 1987, 17).

Geography has also been exploited in presenting simplified cartographies of human lineages, 'akin to creation myths', that conducted ideological power (Livingstone 2010, 205; Nash 2005). But evolutionary thought may reflect and influence social and political-economic processes more by its corollary myth of development as genetically given – bolstered by mapping genes and 'putting the gene in its place' (Hall 2003, 159; *cf.* Hinchliffe 2001) – than by its origin story.

Consider Ridley's (1996, 261-264) use of evolutionary theory to justify Thatcher's assertion "there's no such thing as society", while portraying intrinsically egalitarian markets as suffering under despotic government, squatting 'like a giant flea upon the back of the nation'. The 'self-made men' Ridley extols make themselves much as genes self-replicate: they don't (Griffiths and Gray 1994). Images of self-replicating genes driving development reflect and indulge self-images as self-made. Both distortions favour inattention to the interdependence of development – our shared incompleteness (Nussbaum 2006) – and "Pareto irrelevant" externalized costs of "making oneself" through unequal exchanges, social and ecological (Hornborg 1998, 2011; Sidanius and Pratto 1999; Bromley 2007).

Ever since Malthusian thought simplified the Irish Potato Famine as a self-inflicted consequence of population growth and discounted Irish resistance as 'the disorderly conduct of a people so degraded by their self-inflicted poverty' (Ross 1998, 44), mutual influences between biological and political-economic thought have naturalised excesses of inequality⁷ by indulging self-made conceptions of one's own fortune and others' misery. Pragmatic and socially influenced selective attention to presumed centralised causal agents in gene-centered biological thought to some extent reflects and exacerbates this politics.

The importance of attention is underscored by Stotz *et al.*'s (2004) unique empirical study of biologists' cognitive activity finding neglect of contextual factors by molecular more than developmental biologists. Hoekstra's (2010) informal survey found geneticists more optimistic than organismal biologists

about imminently “knowing it all”. Beyond its partial basis in epistemological naivety and cognitive miserliness, what social processes surround this exhuberance? Stotz *et al.* suggest that for biologists, the gene concept may function like a stereotype. The point is not that biologists are ideologues, but that science is fundamentally a social process. Social influences on, and consequences of, the science of who we are and how we came to be tend to remain tacit, naturalised and resistant to critical reflection.⁸ Scientists who warn against social and ideological influences (e.g. Segerstrale 2000, 341) are themselves influenced (Laland and Brown 2002, 97).⁹

‘Scientific progress is very much about improving the metaphors we use so that our interventions in the world are more successful’ (Sayer 2000, 78). Whatever their own understanding of the complexity of genes’ interactions with other developmental resources, biologists should appreciate the social implications – and consequences for their own thinking – of their metaphorical references to genes as blueprints or programs making ‘a deterministic reading of claims about the role of genes in development almost inevitable’ (Griffiths 2006, 192). Intended or not, the idea of evolution thus accommodates historicism’s “inevitable” (Popper 1957; Beatty 2001), seen today more in geographically distributed transnational capitalism than in national totalitarianism. Both rely on shrinking volition and thereby also moral concerns and political alternatives, succinctly expressed when Thatcher dusted off Spencer’s ‘there is no alternative’.

Also accommodated is the tendency, mischievous because commonsensical, to draw lines among ourselves defining essentially different categories of people. Current expressions of biologically essentialist thought include framing wage suppression in terms of immigration by the alien “other” rather than fair wages for labor. Especially vulnerable are portrayals of the past, as when ethnic labels are applied to genetic lineages. While genes’ bookkeeping features provide useful tools for phylogeography and researchers themselves generally appreciate the complexity of the history they model, common sense uses of categorical terms to summarise findings can bias readers’ understanding toward simplified and divisive origin myths that exaggerate group stability, purity and distinctiveness. Freighted with social significance, genetic studies demand great interpretive vigilance (Terrell 2010).

Biological thought includes an understanding that we are made by our participation in relationships and communities in for example developmental systems theory (Oyama, Griffiths and Gray 2001), developmental psychobiology (Gottlieb 1992, 2003), the expanded evolutionary synthesis of Jablonka and Lamb (2007) and ecological developmental biology (Gilbert and Epel 2009). The developmental biological insight that ‘to be one is always to become with many’ (Haraway 2008, 4) is expressed in political-economic activity: in appreciating the broad benefits and responsibilities, for each individual, of public investments and citizenship; when political processes maintain healthy levels of equality by affirming the fundamental complementarity – not simple opposition – of autonomy and solidarity,

individual and collective, economic performance and social justice (Bauman 2008a; Clark and Clark 2009; Sayer 2011); and when community-based co-management of resources proves an effective alternative to wholesale privatization or state control, driven by these same slants of theory (Gutierrez *et al.* 2011; *cf.* Scott 1998).

By contrast, when US Treasury Secretary Paulson described escalating inequality as ‘simply an economic reality’ about which ‘it is neither fair nor useful to blame any political party’ (quoted in Bartels 2008, 296), markets are construed as pre-political facts of nature. This illusion relies on those strands of preformationist, essentialist biological thought (Keller 2005; Bastian and Haslam 2006) that ease the reduction of society to a population of atomized individuals, which together: buttress the individualistic basis of neoclassical economics and associated neoliberal politics; lower reputational costs of placing self-interest over the group; exacerbate tendencies to blame individuals when markets fail, leading to system under-correction (Jost *et al.* 2003); entrench fair market ideology and its unequal consequences (Blount 2000); expand the political subjectivity of possessive individualism; and divide rank and file with naturalised competition between individuals and their more or less praiseworthy genes (Clark 2007).¹⁰ Where this individualism by molecularisation prevails, a robust politics is less thinkable.

The relation between essentialist attributions to individual biology and tolerance for inequality is reflected in remarkable temporal coincidences within the US, now the most unequal among wealthy countries. Through most of the

mid-century “Great Compression” of US incomes (Goldin and Margo 1992) human genetics was ‘largely silent about those complex patterns such as insanity, criminality, or vagrancy that had so infatuated the eugenicists’ prior to this period of relative income equality (Sarkar 1998, 1-2). The post-1979 “Great Divergence” of US incomes (Krugman 2007) coincided with a return to immodest claims of genetic explanations of complex human behavioural patterns, ‘offered with a qualitatively new degree of precision or ... the appearance of such precision’ (Sarkar 1998, 2). This shift followed Wilson’s (1994, 333) ‘exceptionally strong hereditarian position ... at a time when nurture had seemingly won.’ Similar divergences characterize many other countries under the global wave of neoliberalisation (Harvey 2005), with far-reaching consequences and human costs (Sayer 2005; Wilkinson and Pickett 2009; Hedin *et al.* 2012).

Other political-economic processes played out during both transitions, most notably the New Deal and World War II at the beginning of the “Great Compression”. Its ending around 1980 came with pervasive and intensifying neoliberalisation, increasing frequency of financial crises, precipitous increase in global capital mobility, vast transfers and concentrations of wealth, income and power, and egalitarianism being increasingly identified with markets and individual property rights (Harvey 2010). Science’s relevance and participation are evident when for example US Republicans, appreciating the coalitional implications of essentialist thought, asked *The Bell Curve* co-author Charles Murray to help orient new congressional representatives (Beder 1997).

However it happens, trends in biological thought fit too easily into the nexus of the currently ascendant ideology of privatization (Bauman 2008b), legitimising by naturalising growing inequalities.

Though criticism of biological thought turned our focus on the geography of thought, this review converges with geographies of emotion and affect (Bondi 2005; Thrift 2005; Barnett 2008; Pile 2010) in underscoring the importance of participation, both in the scientific process and as a scientific construct (Demeritt 2008; kinpaisby 2008). The geography of emotional responses to the suite of social consequences of essentialist and deterministic lay thought would complement our analysis, much as inclusion of social psychological processes in this analysis supplements Thrift's (2004) review. Though further attention to emotion is beyond the scope of this article, we caution against using spatial metaphors of emotions as "underlying" social processes (Oyama 2000a; Moore 2008) and overextending non-intentional modes of relating in non-representational theory and other relational ontologies.

Participation in Sustainability

The meanings of sustainability are deeply contested (Davison 2001). Its sloganeering rests on shaky ground (Worster 1993). Heavily exploited for marketing commodities and places, sustainability has become a discursive resource for enhancing profits and legitimising various forms of accumulation by dispossession – unsustainable from just about any social-ecological perspective. Green-washing is a reminder that the power of representation does

not necessarily correspond with its accuracy. Yet the Holocene extinction (Eldridge 1998) associated with habitat destruction, massive production and diffusion of toxins (Colborn *et al.* 1997) and the more publicised changes in climate make it clear that neglecting sustainability is a sure pathway to ‘self-organized extinction’ (Gowdy 2007, 27). Sustainability is ‘the art of keeping the future navigable’ (Hägerstrand 2009, 187 our translation). There are many alternative pathways within the unclear yet ultimate limits of sustainability (Schellnhuber 1999).

Biological thought affects sustainability by informing how we farm, fish, make sense of ourselves, and regard each other. With life forms given in genetic packets and markets comprised of selfish, competing individuals the natural, pre-political order, large-scale crop monoculture makes good sense. Having lent efficiency to the accumulation of capital through labor intensive, extractive, colonial plantations, monoculture has become synonymous with genetically engineered or otherwise uniform crops in pursuit of the “common good” of economic efficiency. Small, complex farms that minimize and internalize ecological costs, protect genetic diversity, and sustain agrarian communities make better sense when life is understood as constructed by diffuse and reciprocal causation within locally adapted communities (Netting 1993). Much of the efficiency achieved on these farms remains off the books in an economy that does not value social and ecological gains and losses. From the vantage point of such farms, the expanding privatization of agricultural biotechnology – what Nally (2011, 46) calls ‘accumulation by

molecularisation’ – is readily seen as meeting near term private interests more than long term public interests (McAfee 2003). The merits of sufficiency (Princen 2005) and the paradox of efficiency (Polimeni *et al.* 2007) are more acutely appreciated.

In 1883, Thomas Huxley argued that ‘Any tendency to overfishing will meet with its natural check in the diminution of the supply, ... this check will always come into operation long before anything like permanent exhaustion has occurred’ (Roberts 2007, 272). Relying heavily on this enticing notion that nature regulates itself, including human activity by way of markets, the Royal Commission of Inquiry on trawling concluded that regulation was not necessary. Garstang (1900) urged greater caution, based on both better data and appreciation of the complexities and contingencies of development.¹¹ Though Huxley’s optimistic projection did not hold up, his argument carried the day and much of the twentieth century as well. While specifics of this argument have fallen out of favour, the broader mind-set persists, complicating efforts to develop effective governance structures to manage global resources (Dietz *et al.* 2003) by rationalizing the commodification of nature under idealized market efficiency narratives (McAfee and Shapiro 2010).

Beyond feeding and provisioning ourselves, biological thought affects prospects for sustainability because the sense we make of ourselves shapes who we become, including our capacities for learning, cooperation and self-regulation. “Knowing” that intelligence is fixed inhibits learning (Blackwell *et al.* 2007). “Knowing” that personality attributes are inherited impels hasty

negative judgments about others, foreclosing opportunities for constructive encounter (Dweck 2000). “Knowing” that free will is illusory engenders cheating (Vohs and Schooler 2008) and aggression (Baumeister *et al.* 2009). And “knowing” that humans are economically selfish by nature favours policies that crowd out reciprocity and trust, inducing self-interested behaviour (Bowles 2008).

So also, “knowing” that political dispositions are a genetic endowment sells short political prospects. And “knowing” that metabolism is natural while intention remains a supernatural specter (Mayr 1961, 1982) hedges responsibility for our extended metabolism – energy consumption – compromising our capacity to regulate our own inventions. Deterministic formulations of ourselves, whether environmental (Radcliffe *et al.* 2010) or genetic, can become self-imposed constraints, just as interpretations of history are themselves forces of history (Plumb 1969; Fairclough *et al.* 2004).

For example, gene-centered thought favours the conclusion that ‘evolutionary analyses are unlikely to provide any cures for our environmental problems and ... often only help us to see why it is difficult to achieve our goals’ (Penn and Mysterud 2007, 8). Against this, understanding human nature as constructed by context-dependent, distributed and reciprocal causation in communities of participants opens up alternatives by moderating the essentialist thought that tends to reflect existing power relations and coalitional intuitions (Boyer 2001), justifying by naturalising socially generated inequalities. Though the relationship is complex (Baland *et al.* 2007), inequality is associated with

wasteful behavior and weaker environmental policies because of: greater discounting of the future by both poor and rich, for different reasons (Boyce 2002); easier externalizing of ecological costs by the more powerful through ecologically unequal exchange; reduced trust degrading cooperation in managing resources sustainably; intensified competition to consume without corresponding increases in well-being; and motivating indiscriminate economic growth to “lift the poor”, accommodating instead of confronting excessive inequality (Wilkinson and Pickett 2009). These ecological consequences of inequality would be mitigated by broader appreciation of developmental systems in understanding the “other”, to the extent this advantages political alternatives that ‘institutionalize the commonality of fate’ over those ‘expressing and promoting the diversity of fate’ (Bauman 1994, 24).

The deeper our appreciation of the essential openness of human nature, the better we face each “other” and, in turn, the better we are able to discern our shared fates and cooperate in exercising our common right to and responsibilities toward place. The right to place¹² is a modern expression of human sociality with deep roots in the vigilant egalitarian cultural practices of our ancestors. Geo-history is agonistic (Mouffe 2005), consisting of ‘struggles for power over the entry of entities and events into space and time’ (Hägerstrand 1986, 43 our translation). How such struggles contingently play out facilitates or hinders sustainability by shaping peoples’ connections to the land and their place.

While history and contingency are recognized in evolutionary theory alongside genes and environments, disproportionate attention is given to chance¹³ or seemingly random but physically determined events such as asteroid strikes (Briggs and Fortey 2005). However prudent scientific wariness of intention, choices forced on or seized by organisms are a distinct aspect of history, within the ineluctable indeterminacy that also shapes the course of evolution. Volitional activity is a force *of nature*, however conditioned on conservative genes, varied environments and untold physiological and psychosocial developmental processes. Recognizing animals' choices – (mis)informed, impulsive, moral, or otherwise – among the contingencies that shape evolutionary change includes human activity more fully within evolutionary thought, exposing conceptual and moral blind spots that bear on sustainability.

From this viewpoint purpose has a place in evolution, only by way of the life histories of organisms. With sighted animals as participants, natural selection is not completely blind, consequences of which are 'grandiose only in the aggregate, and in retrospect; up close and confined in time, they are ordinary' (Margulis and Sagan 1995, 224). Within human biological development and evolution there is a margin of reach which perspective may render either trifling or abundant.

Keeping the future navigable demands reaching with the best of our egalitarian heritage and ideals, today's economic fairness being a foundation for tomorrow's intergenerational environmental justice (Wallerstein 2007). Some

innovations that succeeded by the standards of a growth economy may be counterproductive by the standards of fulfillment within a sustainable economy. Given the possible down-sides of this transition, success depends crucially on social dimensions of innovation (Kallis 2011). A more accurately open image of human nature in evolutionary and folk biologies, in scientific and lay theories, would itself be a social innovation helping us attend to alternatives, open up sites of transformative space (Langley and Mellor 2002) and develop the social capital to confront the constraints and uncertainties, and identify the opportunities, of transitioning toward sustainable living (Harvey 2000; Pretty 2003).

Conclusion

Sailing the Mediterranean, Ulysses would have seen ‘abundant monk seal, loggerhead turtles and porpoises’ (Roberts 2007, 375). Not today. The ‘juggernaut, improvement’ has rolled over habitation (Polanyi 2001, 191), fraying the weave of life. Meanwhile, the modern synthesis of genetics with evolution has been more committed to simpling man into causal theories than stretching theories to include the purposeful behaviour of man and other animals. Human inventiveness, regarded by the modern synthesis as the evolutionary consequence of climate variability (Potts 1996), has begun causing climate variability.

To take full account of insects, ostriches or humanity, biology must recognize the participation of animals in their own development and evolution.

More is at stake than a robust theory of evolution. Because sustainability is as much about managing ourselves and each other as managing resources, the sense we make of ourselves can limit or leverage sustainability achievements. Biology's neglect of consistency regarding intention and participation, drolly conceded by Haldane and seeming wise when Polanyi diagnosed it over a half century ago, is no longer wise.

Mayr's (1959, 13) claim that 'the very survival of man on this globe may depend on a correct understanding of the evolutionary forces and their application to man' must be understood in light of Waddington's (1960; *cf.* Lewontin 2000) view of man and other animals as both objects, to which evolutionary forces apply, and subjects, themselves evolutionary forces. Recognising our ancestors and ourselves as participants in evolution is vital to sustainability aspirations, as it animates healthful consideration of the responsibilities that come with our deft inventiveness. Theory that hollows out volition diminishes responsibility.

Awkwardly appended declarations of responsibility are poor substitutes for baking it into the theoretical cake. Simpson's (1960; 973) is one of many such declarations in which it is unclear how people's 'sense of responsibility' ensues from an evolutionary process in which 'the mechanism of orientation, the non-random element' is 'blind' natural selection. Vermeij (2010, 250) emphasizes the continuity of animal and human intentionality before inexplicably negating its evolutionary relevance, vitiating responsibility, by asserting that the 'details of time, place and player' of selection 'reside fully in the realm of inscrutable

chance.’ Having at once trivialized participation and belittled our ancestors, Vermeij’s hopes for mankind emphasize philanthropy by naturally occurring superrich, not social and economic fairness and the broader participation in solutions this entails. Some biologists have wanted to own the bicycle of intention and responsibility without riding it (*cf.* Gould 2002, 256).

Bearing hallmark features of a major evolutionary transition (Wilson and Wilson 2007), human eusociality – good sociality – was achieved by the conscious participation of our ancestors in recognizing shared fates and cultivating responsibility to each other, in societies that cannot be coherently dissolved into populations of atomized individuals (Fracchia and Lewontin 1999). Having played some part in this transition, between-group conflict need not become a self-fulfilling, theoretically blinkered expectation distracting us from seeing clearly both our increasingly shared ecological fates and our capacities for cooperation between groups in achieving sustainability goals.

Recent work of biological and social scientists reveals misplaced concreteness (Whitehead 1978) in thinking about human nature as an unfounded constraint on human adaptability. Among other ways scientists stand to help manage anthropogenic global changes (Travis and Futuyma 1993; ICSU 2010), we appeal for affirming in theory and in the public square an image of human nature ‘that presents people as able to make their history ... [and] as obliged to do so’ (Bock 1994, 116). Achieving the collective self-regulation sustainability requires may depend on correcting slanted reasoning about ourselves.

Notes

¹ Huxley (1942) coined the term “modern synthesis” to describe the synthesis of evolutionary theory with other areas of biology, prominently including the young science of genetics while marginalizing developmental biology. Simpson (1960) and Mayr (1982) expressed similar views on Darwin’s position, consigning behavior, except as it is controlled by genetically given “programs”, to the realms of superstition and decisively refuted “soft inheritance”.

² This conflation is echoed in EO Wilson’s (2005, 30) conclusion that evolution, lacking external guidance, is therefore ‘blind’, and in DS Wilson’s (2007, 92) pejorative ‘secular creationists’, describing social scientists who reject facile overextensions of “genetic evolution” as unfounded and socially consequential. Wilson’s epithet confuses recognition of emergent processes in development with belief in externally directed evolution.

³ The brain has been similarly privileged vis-à-vis behaviour (Bakker 1984).

⁴ See Plotkin (1988, 2, 143) on the occasional nods to behaviour.

⁵ Sadness evoked by this “scientificity” toward life registers an intuitive grasp of its failings. On the silencing of such emotion, see Anderson and Smith (2001).

⁶ Because of the advantages of plasticity, genetic assimilation of behavioral adaptations may have more costs than benefits (*cf.* Mayr 1963, 612).

⁷ A secular continuation of inherited power in monarchies based on divine essentialism.

⁸ The nature of these social consequences is ‘not strongly influenced by the efforts of the core scientists. They merely catalyze what is already happening ...’ (Strand 2000, 453).

⁹ We make no exceptions for ourselves and warn instead against indifference toward or claims of immunity from such influences.

¹⁰ Clark places behaviour in a causal evolutionary role, but his attributions of “genetic” class differences rest on poor biological modeling – application to a non-isolated subpopulation within a short time frame.

¹¹ Garstang (1922) later argued that modifications in ontogeny can influence the course of evolution, placing him in the company of Gullick, Waddington, Ewar and Piaget, noted above.

¹² With right to place we refer to the right to the city (Harvey 2003; Mitchell 2003; Purcell 2008) in its broadest sense of citizenship, beyond the city limits (cf. Harvey 2000, 248-252).

¹³ Orians (2007) commends Monod’s (1971, 113) assertion of chance’s universal and exclusive role in evolutionary innovation. Darwinian in neither substance nor style, Monod’s pronouncement engenders more than it explains the resistance to evolutionary thought he dismisses as ‘instinctive’.

Acknowledgements

We appreciate the helpful comments and critique of Alison Blunt, Bob Brantly, Jeff Chanton, Elizabeth Clark, Randy Earnest, Martin Evans, Michael Jones, Jean-Louis Rallu, Andrew Sayer, John Terrell, Andy Thomas and two anonymous reviewers. Thanks also to participants at the Islands in Social Theory conference, IGU Commission on Islands, Ven, Sweden, and to John Wylie and participants in the sessions on Human Remains: The place of the human in a post-human world, at the 4th Nordic Geographers Meeting, Roskilde, Denmark, where we presented drafts of this article.

References

- Anderson K and Smith S J** 2001 Emotional geographies *Transactions of the Institute of British Geographers* 26 7-10
- Bakker D** 1984 The brain as a dependent variable *Journal of Clinical and Experimental Psychology* 6 1-16
- Baland J-M, Bardhan P and Bowles S** 2007 *Inequality, cooperation, and environmental sustainability* Princeton University Press, Princeton
- Barnett C** 2008 Political affects in public space: normative blind-spots in non-representational ontologies *Transactions of the Institute of British Geographers NS* 33 186-200
- Bartels L M** 2008 *Unequal democracy* Princeton University Press, Princeton
- Bastian B and Haslam N** 2006 Psychological essentialism and stereotype endorsement *Journal of Experimental Social Psychology* 42 228-35

- Bateson P and Mameli M** 2007 The innate and the acquired: useful clusters or a residual distinction from folk biology? *Developmental Psychobiology* 49 818-31
- Bauman Z** 1994 *Alone again: ethics after certainty* Demos, London
- Bauman Z** 2008a *Does ethics have a chance in a world of consumers?* Harvard University Press, Cambridge MA
- Bauman Z** 2008b *The art of life* Polity Press, Cambridge
- Baumeister R F, Masicampo E J and DeWall C N** 2009 Prosocial benefits of feeling free: disbelief in free will increases aggression and reduces helpfulness *Personality and Social Psychology Bulletin* 35 260-68
- Beatty J** 2001 Hannah Arendt and Karl Popper: Darwinism, historical determinism, and totalitarianism in **Singh R S, Krimbas C B, Paul D B and Beatty J** eds *Thinking about evolution* Cambridge University Press, Cambridge
- Beder S** 1997 *Global spin* Chelsea Green Publishing, White River Junction VT
- Blackwell L S, Trzesniewski K H and Dweck C S** 2007 Implicit theories of intelligence predict achievement across an adolescent transition: a longitudinal study and an intervention *Child Development* 78 246-63
- Blakey M L** 1998 Beyond European Enlightenment: toward a critical and humanistic human biology in **Goodman A H and Leatherman T L** eds *Building a new biocultural synthesis* University of Michigan Press, Ann Arbor

- Blount S** 2000 Whoever said that markets were fair? *Negotiation Journal* 16 237-52
- Bock K** 1994 *Human nature mythology* University of Illinois Press, Chicago
- Boehm C** 1999 *Hierarchy in the forest* Harvard University Press, Cambridge MA
- Boehm C** 2008 Purposive social selection and the evolution of human altruism *Cross-Cultural Research* 42 319-52
- Boehm C and Flack J C** 2010 The emergence of simple and complex power structures through social niche construction in **Guinote A and Vescio T K** eds *The social psychology of power* Guilford Press, New York
- Bondi L** 2005 Making connections and thinking through emotions: between geography and psychotherapy *Transactions of the Institute of British Geographers NS* 30 433-48
- Bowles S** 2008 Policies designed for self-interested citizens may undermine “the moral sentiments”: evidence from economic experiments *Science* 320 1605-09
- Boyce J K** 2002 *The political economy of the environment* Edward Elgar Publishing, Cheltenham
- Boyer P** 2001 *Religion explained* Basic Books, New York
- Briggs D E G and Fortey R A** 2005 Wonderful strife: systematics, stem groups, and the phylogenetic signal of the Cambrian radiation *Paleobiology* 31 94-112

- Bromley D W** 2007 Environmental regulations and the problem of sustainability: moving beyond “market failure” *Ecological Economics* 63 676-83
- Burkhardt R W** 1970 Lamarck, evolution and the politics of science *Journal of the History of Biology* 3 275-98
- Castree N** 2009 Who’s afraid of Darwin? *Geoforum* 40 941-44
- Clark E and Clark T L** 2009 Isolating connections – connecting isolation *Geografiska Annaler Series B Human Geography* 91 311-23
- Clark G** 2007 *A farewell to alms* Princeton University Press, Princeton
- Clayton D F, Balakrishnan C N and London S E** 2009 Integrating genomes, brain and behavior in the study of songbirds *Current Biology* 19 865-73
- Cliff A, Haggett P and Smallman-Raynor M** 2000 *Island epidemics* Oxford University Press, Oxford
- Colborn T, Dumanoski D and Myers J P** 1997 *Our stolen future* Plume, New York
- Darwin C** 1964 [1859 and Sixth Edition, 1872] *On the origin of species by means of natural selection or the preservation of favored races in the struggle for life* Facsimile ed **Mayr E** Murray, London
- Davison A** 2001 *Technology and the contested meanings of sustainability* SUNY Press, Albany NY
- Demeritt D** 2008 From externality to inputs and interference: framing environmental research in geography *Transactions of the Institute of British Geographers NS* 34 3-11

- Dietz T, Ostrom E and Stern P C** 2003 The struggle to govern the commons
Science 302 1907-12
- Duckworth R A** 2009 The role of behavior in evolution: a search for
mechanism *Evolutionary Ecology* 23 513-31
- Dweck C S** 2000 *Self-theories* Psychology Press, Philadelphia
- Eldridge N** 1998 *Life in the balance: humanity and the biodiversity crisis*
Princeton University Press, Princeton NJ
- Ewer R F** 1960 Natural selection and neoteny *Acta Biotheoretica* 13 161-84
- Fairclough N, Jessop B and Sayer A** 2004 Critical realism and semiosis in
Joseph J and Roberts J eds *Realism, discourse and deconstruction*
Routledge, London
- Fiske S T** 2000 Stereotyping, prejudice, and discrimination at the seam
between the centuries: evolution, culture, mind, and brain *European
Journal of Social Psychology* 30 299-322
- Fracchia J and Lewontin R C** 1999 Does culture evolve? *History and Theory*
38 52-78
- Gannett L** 1999 What's in a cause? The pragmatic dimensions of genetic
explanations *Biology & Philosophy* 14 349-74
- Garstang W** 1900 The impoverishment of the sea *Journal of the Marine
Biological Association of the UK* 6 1-69
- Garstang W** 1922 The theory of recapitulation: a critical re-statement of the
biogenetic law *Journal of the Linnean Society of London, Zoology* 35
81-101

- Gelli G B** 1963 [1548] *Circe* **Brown T** translator **Adams R M** ed Cornell University Press, Ithaca NY
- Gilbert S F and Epel D** 2009 *Ecological Developmental Biology* Sinauer, Sunderland MA
- Goldin C and Margo R A** 1992 The great compression: wage structure in the United States at mid-century *Quarterly Journal of Economics* 107 1-34
- Goodenough U and Deacon T W** 2003 From biology to consciousness to morality *Zygon* 38 801-19
- Gottlieb G** 1992 *Individual development and evolution: the genesis of novel behavior* Oxford University Press, Oxford
- Gottlieb G** 2003 On making behavioral genetics truly developmental *Human Development* 46 337-55
- Gould S J** 1987 Kropotkin was no crackpot *Natural History* 97 7 12-21
- Gould S J** 2001 The evolutionary definition of selective agency, validation of the theory of hierarchical selection, and fallacy of the selfish gene in **Singh R S, Krimbas C B, Paul D B and Beatty J** eds *Thinking about evolution* Cambridge University Press, Cambridge
- Gould S J** 2002 *The structure of evolutionary theory* Harvard University Press, Cambridge MA
- Gowdy J** 2007 Avoiding self-organized extinction: toward a coevolutionary economics of sustainability *International Journal of Sustainable Development & World Ecology* 14 27-36
- Grant P** ed 1998 *Evolution on islands* Oxford University Press, Oxford

- Grant P R and Grant B R** 2008 *How and why species multiply: the radiation of Darwin's finches* Princeton University Press, Princeton
- Greenhough B** 2006 Tales of an island-laboratory: defining the field in geography and science studies *Transactions of the Institute of British Geographers NS* 31 224-38
- Griffiths P E** 2006 The fearless vampire conservator: Philip Kitcher, genetic determinism, and the informational gene in **Neumann-Held E M and Rehmann-Sutter C** eds *Genes in development* Duke University Press, Durham NC
- Griffiths P E and Gray R D** 1994 Developmental systems and evolutionary explanation *Journal of Philosophy* 91 277-304
- Gullick J T** 1905 *Evolution, racial and habitudinal* Carnegie Institution, Washington DC
- Gutierrez N L, Hilborn R and Defeo O** 2011 Leadership, social capital and incentives promote successful fisheries *Nature* 470 386-89
- Hägerstrand T** 2009 *Tillvaroväven* [The weave of existence] Edited by **Ellegård K and Svedin U** Forskningsrådet Formas, Stockholm
- Hägerstrand T** 1986 Den geografiska traditionens kärnområde *Svensk Geografisk Årsbok* 62 38-43
- Hall E** 2003 Reading maps of the genes: interpreting the spatiality of genetic knowledge *Health & Place* 9 151-61
- Haraway D J** 2008 *When species meet* University of Minnesota Press, Minneapolis

- Harvey D** 2000 *Spaces of hope* University of California Press, Berkeley
- Harvey D** 2003 The right to the city *International Journal of Urban and Regional Research* 27 939-41
- Harvey D** 2005 *A brief history of neoliberalism* Oxford University Press, Oxford
- Harvey D** 2010 *The enigma of capital* Oxford University Press, Oxford
- Haslam N, Bastian B, Bain P and Kashima Y** 2006 Psychological essentialism, implicit theories, and intergroup relations *Group Processes & Intergroup Relations* 9 63-76
- Hedin K, Clark E, Lundholm E and Malmberg G** 2012 Neoliberalization of housing in Sweden: gentrification, filtering and social polarization *Annals of the Association of American Geographers* 102 (in press)
- Hinchliffe S** 2001 Indeterminacy in-decisions – science, policy and politics in the BSE (Bovine Spongiform Encephalopathy) crisis *Transactions of the Institute of British Geographers NS* 26 182-204
- Hoekstra H E** 2010 Evolutionary biology: the next 150 years in **Bell M A, Futuyma D J, Eanes W F and Levinton J S** eds *Evolution since Darwin* Sinauer, Sunderland MA
- Hornborg A** 1998 Towards an ecological theory of unequal exchange: articulating world system theory and ecological economics *Ecological Economics* 25 127-36
- Hornborg A** 2011 Global environmental history *Encyclopedia of Life Support Systems* UNESCO (in print)

- Hull D L** 1982 Philosophy and biology in **Floistad G** *Contemporary philosophy* Martinus Nijhoff, The Hague
- Huxley J** 1942 *Evolution: the modern synthesis* Allen & Unwin, London
- Huxley J** 1960 The emergence of Darwinism in **Tax S** ed *Evolution after Darwin* Vol 1 *The evolution of life* University of Chicago Press, Chicago
- ICSU [International Council for Science]** 2010 Earth system science for global sustainability: the grand challenges
- Jablonka E and Lamb M J** 2007 The expanded evolutionary synthesis – a response to Godfrey-Smith, Haig and West-Eberhard *Biology & Philosophy* 22 453-72
- Jarvis E D, Scharff C, Grossman M R, Ramos J A and Nottebohm F** 1998 For whom the bird sings: context-dependent gene expression *Neuron* 21 775-788
- Jost J T, Blount S, Pfeffer J and Hunyady G** 2003 Fair market ideology: its cognitive-motivational underpinnings *Research in Organizational Behavior* 25 53-91
- Kallis G** 2011 In defence of degrowth *Ecological Economics* 70 873-80
- Kashima Y, Kashima E, Chiu C, Farsides T, Gelfand M, Hong Y, Kim U, Strack F, Werth L, Yuki M and Yzerbyt V** 2005 Culture, essentialism and agency: are individuals universally believed to be more real entities than groups? *European Journal of Social Psychology* 35 147-69
- Kearns G** 2010 Geography, geopolitics and empire *Transactions of the Institute of British Geographers NS* 35 187-203

- Keller J** 2005 In genes we Trust: the biological component of psychological essentialism and its relationship to mechanisms of motivated social cognition *Journal of Personality and Social Psychology* 88 686-702
- kinpaisby mrs** 2008 Taking stock of participatory geographies: envisioning the communitary *Transactions of the Institute of British Geographers NS* 33 292-99
- Koch S** 1981 The nature and limits of psychological knowledge: lessons of a century *qua* 'science' *American Psychologist* 36 257-69
- Krugman P** 2007 *The conscience of a liberal* W W Norton, New York
- Laland K N and Brown G R** 2002 *Sense and nonsense* Oxford University Press, Oxford
- Langley P and Mellor M** 2002 'Economy', sustainability and sites of transformative space *New Political Economy* 7 49-65
- Leakey R E** 2010 *Why our origins matter* Public lecture *Origins '10* Florida State University April 1
- Lerner I M** 1959 The concept of natural selection: a centennial view *Proceedings of the American Philosophical Society* 103 173-82
- Levy S R, Chiu C and Hong Y** 2006 Lay theories and intergroup relations *Group Processes & Intergroup Relations* 9 5-24
- Lewontin R** 1974 The analysis of variance and the analysis of causes *American Journal of Human Genetics* 26 400-11
- Lewontin R** 2000 *The triple helix* Harvard University Press, Cambridge MA

- Lewontin R and Levins R** 2007 *Biology under the influence* Monthly Review Press, New York
- Livingstone D N** 2003 *Putting science in its place* University of Chicago Press, Chicago
- Livingstone D N** 2010 Cultural politics and the racial cartographics of human origins *Transactions of the Institute of British Geographers NS* 35 204-21
- MacArthur R H and Wilson E O** 1967 *The theory of island biogeography* Princeton University Press, Princeton
- Margulis L and Sagan D** 1995 *What is life?* Simon & Schuster, New York
- Mayr E** 1959 Where are we? *Cold Spring Harbor Symposia on Quantitative Biology* 24 1-14
- Mayr E** 1961 Cause and effect in biology *Science* 134 1501-06
- Mayr E** 1963 *Animals, species and evolution* Harvard University Press, Cambridge MA
- Mayr E** 1982 *The growth of biological thought* Harvard University Press, Cambridge MA
- McAfee K** 2003 Neoliberalism on the molecular scale: economic and genetic reductionism in biotechnology battles *Geoforum* 34 203-19
- McAfee K and Shapiro E N** 2010 Payments for ecosystem services in Mexico: nature, neoliberalism, social movements, and the state *Annals of the Association of American Geographers* 100 579-99

- Meagher T G and Futuyma D J** 2001 Supplement: Executive document: evolution, science, and society *American Naturalist* 158, 1-42
- Mitchell D** 2003 *The right to the city: social justice and the fight for public space* Guilford, New York
- Monod J** 1971 *Chance and necessity* Alfred A Knopf, New York
- Moore D S** 2008 Espousing interactions and fielding reactions: addressing laypeople's beliefs about genetic determinism *Philosophical Psychology* 21 331-48
- Mouffe C** 2005 *On the political* Routledge, Abingdon
- Nally D** 2011 The biopolitics of food provisioning *Transactions of the Institute of British Geographers* 36 37-53
- Nash C** 2005 Geographies of relatedness *Transactions of the Institute of British Geographers NS* 30 449-62
- Netting R M** 1993 *Smallholders, householders: farm families and the ecology of intensive, sustainable agriculture* Stanford University Press, Stanford
- Nisbett R E** 2003 *The geography of thought* Free Press, New York
- Nussbaum M C** 2006 *Frontiers of justice* Princeton University Press, Princeton NJ
- Orians G H** 2007 Human behavioral ecology: 140 years without Darwin is too long in **Penn D J and Mysterud I** eds *Evolutionary perspectives on environmental problems* Transaction Publishers, New Brunswick NJ
- Owens I P F** 2008 Think different *Trends in Ecology and Evolution* 23, 185-86
- Oyama S** 2000a *Evolution's eye* Duke University Press, Durham

- Oyama S** 2000b Causal democracy and causal contributions in developmental systems theory *Philosophy of Science* 67 S332-47
- Oyama S, Griffiths P E and Gray R D** eds 2001 *Cycles of contingency: developmental systems and evolution* MIT Press, Cambridge MA
- Penn D J and Mysterud I** eds 2007 *Evolutionary perspectives on environmental problems* Transaction Publishers, New Brunswick NJ
- Piaget J** 1971 *Biology and knowledge* University of Chicago Press, Chicago
- Pile S** 2010 Emotions and affect in recent human geography *Transactions of the Institute of British Geographers NS* 35 5-20
- Plaks J E, Stroessner S J, Dweck C S and Sherman J W** 2001 Person theories and attention allocation: preferences for stereotypic versus counterstereotypic information *Journal of Personality and Social Psychology* 80 876-93
- Plotkin H C** 1988 *The role of behavior in evolution* MIT Press, Cambridge MA
- Plumb J H** 1969 *The death of the past* Macmillan, London
- Polanyi K** 2001 [1944] *The great transformation* Beacon Press, Boston
- Polanyi M** 1957 Scientific outlook: its sickness and cure *Science* 125 480-84
- Polimeni J M, Mayumi K, Giampietro M and Alcott B** 2007 *The Jevons paradox and the myth of resource efficiency improvements* Earthscan, London
- Popper K** 1957 *The poverty of historicism* Harper, New York
- Potts R** 1996 Evolution and climate variability *Science* 273 922-23

- Potts R and Sloan C** 2010 *What does it mean to be human?* National Geographic Society, Washington DC
- Pretty J** 2003 Social capital and the collective management of resources
Science 302 1912-14
- Price T** 2008 *Speciation in birds* Roberts, Boulder CO
- Price T D, Qvarnstrom A and Irwin D E** 2003 The role of phenotypic plasticity in driving genetic evolution. *Proceedings of the Royal Society B* 270 1433-40
- Princen T** 2005 *The logic of sufficiency* MIT Press, Cambridge MA
- Purcell M** 2008 *Recapturing democracy: neoliberalization and the struggle for alternative urban futures* Routledge, New York
- Radcliffe S A, Watson E E, Simmons I, Fernández-Armesto F and Sluyter A** 2010 Environmentalist thinking and/in geography *Progress in Human Geography* 34 98-116]
- Richards M** 2003 The Neolithic invasion of Europe *Annual Review of Anthropology* 32 135-62
- Ridley, M** 1996 [1998] *The origins of virtue* Penguin Books, London
- Roberts C** 2007 *The unnatural history of the sea* Island Press, Washington DC
- Ross E B** 1998 *The Malthus factor* Zed Books, London
- Sahlins M** 2008 *The Western illusion of human nature* Prickly Paradigm Press, Chicago
- Sarkar S** 1998 *Genetics and reductionism* Cambridge University Press, Cambridge

- Sarkar S** 1999 From the *reaktionsnorm* to the adaptive norm: the norm of reaction, 1909-1960 *Biology and Philosophy* 14 235-52
- Sarkar S** 2006 From genes as determinants to DNA as resource in **Neumann-Held E M and Rehmann-Sutter C** eds *Genes in development* Duke University Press, Durham NC
- Sayer A** 2000 *Realism and social science* SAGE, London
- Sayer A** 2005 *The moral significance of class* Cambridge University Press, Cambridge
- Sayer A** 2011 *Why things matter to people* Cambridge University Press, Cambridge
- Schellnhuber H J** 1999 'Earth system' analysis and the second Copernican revolution *Nature* 402 (6761supp) C19–C23
- Scott J C** 1998 *Seeing like a state* Yale University Press, New Haven
- Segerstrale U** 2000 *Defenders of the truth* Oxford University Press, Oxford
- Sidanius J and Pratto F** 1999 *Social dominance* Cambridge University Press, Cambridge
- Simpson G G** 1960 The world into which Darwin led us *Science* 131 966-74
- Sol D, Timmermans S and Lefebvre L** 2002 Behavioural flexibility and invasion success in birds *Animal Behaviour* 63 495-502
- Sol D, Duncan R P, Blackburn T M, Cassey P and Lefebvre L** 2005a Big brains, enhanced cognition, and response of birds to novel environments *Proceedings of the National Academy of Sciences* 102 5460-65

- Sol D, Lefebvre L and Rodriquez-Teijeiro J D** 2005b Brain size, innovative propensity and migratory behavior in temperate Palaearctic birds
Proceedings of the Royal Society B 272 1433-41
- Sol D, Stirling D G and Lefebvre L** 2005c Behavioral drive or behavioral inhibition in evolution: subspecific diversification in holarctic passerines *Evolution* 59 2669-77
- Stotz K, Griffiths P E and Knight R** 2004 How biologists conceptualize genes: an empirical study *Studies in History and Philosophy of Biological and Biomedical Sciences* 35 647-73
- Strand R.** 2000 Naivety in the molecular life sciences *Futures* 32 451-70
- Taylor P** 1998 How does the commons become tragic: simple models as complex socio-political constructions *Science as Culture* 7 449-64
- Templeton A R** 1998 Human races: a genetic and evolutionary perspective *American Anthropologist* 100 632-50
- Terrell J E** 1986 *Prehistory in the Pacific Islands* Cambridge University Press, Cambridge
- Terrell J E** 2010 Polynesians and the seductive power of common sense Paper presented at Islands in Social Theory, IGU Commission on Islands Conference, Ven, Sweden, 27-30 August
- Thrift N** 2004 Intensities of feeling: towards a spatial politics of affect
Geografiska Annaler Series B Human Geography 86 57-78
- Thrift N** 2005 From born to made: technology, biology and space *Transactions of the Institute of British Geographers NS* 30 463-76

- Travis J and Futuyma D J** 1993 Global change: lessons from and for evolutionary biology in **Kareiva P M, Kingsolver J G and Huey R B** eds *Biotic interactions and global change* Sinauer, Sunderland MA
- Vermeij G** 2010 *The evolutionary world* St. Martins Press, New York
- Vohs K D and Schooler J W** 2008 The value of believing in free will: encouraging a belief in determinism increases cheating *Psychological Science* 19 49-54
- de Waal F** 2001a *The ape and the sushi master* Basic Books, New York
- de Waal F** 2001b Without walls *New Scientist* 172 46-49
- Waddington C H** 1960 Evolutionary adaptation in **Tax S** ed *Evolution after Darwin* Vol 1 *The evolution of life* University of Chicago Press, Chicago
- Warf B** 2008 *Time-space compression: historical geographies* Routledge, London
- Wallerstein I** 2007 The ecology and the economy: what is rational? in **Hornborg A, McNiell J R and Martinez-Alier J** eds *Rethinking environmental history: world-system history and global environmental change* AltaMira Press, Lanham MD
- Whitehead A N** 1962 [1929] *The function of reason* Beacon Press, Boston
- Whitehead A N** 1978 [1929] *Process and reality* Free Press, New York
- Wilkinson R and Pickett K** 2009 *The spirit level* Allen Lane, London
- Wilson D S** 2007 *Evolution for everyone* Random House, New York
- Wilson D S and Wilson E O** 2007 Rethinking the theoretical foundation of sociobiology *The Quarterly Review of Biology* 82 327-48
- Wilson E O** 1994 *Naturalist* Island Press, Washington DC

Wilson E O 2005 Intelligent evolution *Harvard Magazine* Nov-Dec 29-33

Worster D 1993 The shaky ground of sustainability in **Sachs W** ed *Global ecology* Zed Books, London

Wrangham R 2009 *Catching fire: how cooking made us human* Basic Books,
New York