



Contents lists available at ScienceDirect

Studies in History and Philosophy of Biological and Biomedical Sciences

journal homepage: www.elsevier.com/locate/shpsc

From ‘circumstances’ to ‘environment’: Herbert Spencer and the origins of the idea of organism–environment interaction

Trevor Pearce

Conceptual and Historical Studies of Science, University of Chicago, Social Sciences 205, 1126 East 59th Street, Chicago, IL 60637, USA

ARTICLE INFO

Keywords:

Herbert Spencer
Environment
Organism–environment interaction
Auguste Comte
Circumstances
George Henry Lewes

ABSTRACT

The word ‘environment’ has a history. Before the mid-nineteenth century, the idea of a singular, abstract entity—the organism—interacting with another singular, abstract entity—the environment—was virtually unknown. In this paper I trace how the idea of a plurality of external conditions or circumstances was replaced by the idea of a singular environment. The central figure behind this shift, at least in Anglo-American intellectual life, was the philosopher Herbert Spencer. I examine Spencer’s work from 1840 to 1855, demonstrating that he was exposed to a variety of discussions of the ‘force of circumstances’ in this period, and was decisively influenced by the ideas of Auguste Comte in the years preceding the publication of *Principles of psychology* (1855). It is this latter work that popularized the word ‘environment’ and the corresponding idea of organism–environment interaction—an idea with important meta-physical and methodological implications. Spencer introduced into the English-speaking world one of our most enduring dichotomies: organism and environment.

© 2010 Elsevier Ltd. All rights reserved.

When citing this paper, please use the full journal title *Studies in History and Philosophy of Biological and Biomedical Sciences*

1. Introduction

The claim that an organism has an environment seems rather mundane today. In the mid-nineteenth century, however, the idea of a singular, abstract entity—the organism—interacting with another singular, abstract entity—the environment—was virtually unknown. Metaphysically, environments are much more problematic than organisms; the latter, at least, are normally physically unified.¹ The word ‘environment’ seems to refer to a mishmash of unrelated entities: sunlight, soil, climate, air, organisms, and so on. Modern philosophers embroiled in debate over whether one can maintain a distinction between organism and environment, such as developmental systems theorists and their critics (cf. Oyama et al., 2001), never consider the question of how the myriad causal factors that make up the environment came to be treated as a single, unified entity. In this paper I will show how, in the nineteenth century, the idea of a plurality of external conditions or circumstances began to be replaced by the idea of a singular environment. The central figure behind this shift, at least in Anglo-American intellectual life, was the philosopher Herbert Spencer.

Spencer’s *Principles of psychology* (1855) was a watershed in the history of ideas about organism–environment interaction. It is now commonplace to quote Crane Brinton’s rhetorical question, ‘Who now reads Spencer?’ (Brinton, 1933, p. 226; cf. Peel, 2004, p. 135). As this suggests, Spencer was no longer taken seriously as a thinker by the 1930s. But prior to this period, everyone read Spencer. The biologist D’Arcy Thompson did not mince words: ‘No philosopher of modern times, not Kant himself, has exercised in his lifetime so wide a dominion’ (Thompson, 1913, p. 3). Spencer’s influence was especially felt in America: upon his death, a letter published in the *Washington Post* proclaimed him to be the ‘greatest Englishman since Shakespeare’ (Kittredge, 1903), and his obituaries frequently referred to him as ‘the last of the great thinkers of the Victorian Age’ (‘Herbert Spencer dead’, 1903; cf. Werth, 2009). Philosophers such as William James and biologists such as August Weismann became famous by defining themselves in opposition to Spencer’s influential views. As Richard Hofstadter has written, one could not ‘be active in any field of intellectual work in the three decades after the Civil War without mastering Spencer’ (Hofstadter, 1944, p. 20).

E-mail address: trpearce@uchicago.edu

¹ This is of course only a relative claim. For debates over biological individuality in Spencer’s time, see Elwick (2007).

History, however, has not been kind to Spencer. Hofstadter himself made Spencer's name synonymous with 'social Darwinism' and racism. According to David Weinstein (2002), Spencer has never fully recovered from the caricatures of Hofstadter and others. Moreover, he tends to fall into the cracks between disciplines: as the pragmatist F. C. S. Schiller pointed out, 'To the specialists in the sciences ... Spencer has often appeared too much of a philosopher and defective in specialist knowledge. To the technical philosophers ... he has, contrariwise, not seemed philosophic enough' (Schiller, 1911, p. 635). In comparison to other important figures, historians of science have thus discussed Spencer rather infrequently (Young, 1970; Peel, 1971; Sharlin, 1976; Smith, 1982; Francis, 1986; R. J. Richards, 1987). In the last decade, however, there has been something of a Spencer renaissance, with a series of important books and essays devoted to his thought (Rylance, 2000; Carneiro & Perrin, 2002; Elliott, 2003; Elwick, 2003; Jones & Peel, 2004; Beck, 2005; Versen, 2006; Gondermann, 2007; Francis, 2007; Taylor, 2007; Dixon, 2008; Renwick, 2009; Werth, 2009).

Two approaches are represented in this literature: one can reassess Spencer's thought, or its reception. For example, Thomas Dixon (2004) reevaluated Spencer's ethical views, and Naomi Beck (2005) investigated his influence on socialist thought. Mark Francis's recent intellectual biography of Spencer takes a third approach, reexamining the *sources* of Spencer's thinking—this is especially clear in his account of the 'lost world of Spencer's metaphysics' (Francis, 2007, pp. 109–186). This paper, like Francis's biography, explores Spencer's sources; but it focuses on a particular idea, namely, organism–environment interaction. Although Francis does discuss Spencer's biological views, and in particular his definition of life, he does not address the idea of organism–environment interaction, so central to Spencer's evolutionary philosophy. My paper is thus complementary to Francis's work.

Any story about the origins of an idea faces a number of historiographical difficulties. Perhaps the most important of these is the distinction between a word and a concept. In this case, both are relevant: the word 'environment' is essential to the concept of organism–environment interaction. The latter, as I will suggest at the end of the paper, became popular because it was an abstract, portable dichotomy produced by the conjunction of two singular terms. Before the word 'environment' was coined, English only possessed plural terms like 'circumstances'. Thus, this paper concerns the initial adoption of the term 'environment' by Spencer, and the concomitant appearance of the idea of organism–environment interaction in his work. I do not assume that all the authors whom Spencer read in the 1840s shared one account of how organisms respond to changes in their circumstances. What matters is that Spencer was familiar with many such accounts, which together informed his idea of organism–environment interaction. Dixon, in his book *The invention of altruism* (2008, p. 33), argues that linguistic change is not merely epiphenomenal—that it 'can be seen as a kind of social, technological, and intellectual change itself, rather than as a map or mirror of such change'.² Spencer's adoption of a new term, 'environment', led to the creation of a new concept, organism–environment interaction. Both the word and the idea proved more portable than past talk of circumstances; for example, the philosopher John Dewey emphasized, from at least the 1890s onwards, the dynamic adaptation of organisms to their environments, and the physician James Walsh listed 'environment' among a whole series of technical biological terms that had entered the vernacular (Dewey, 1898, p. 338; Walsh, 1900, p. 466, cited in Dixon, 2008, p. 280). The singular term 'environment', the resulting portable dichotomy, and the application of the idea to intellectual

and social as well as biological domains all helped to popularize Spencer's account of organism–environment interaction.

In this paper, I will argue that while Spencer's exposure to manifold biological ideas in the 1840s was essential in shaping his dynamic view of organisms, his encounter with Auguste Comte in the 1850s led to a new idea of life based on organism–environment interaction and to a new term, 'environment'. This transition marks the birth of the idea of organism–environment interaction—both in Spencer's thinking and in Anglo-American thought more generally. Returning to the origins of this idea provides important background for the 1890s 'factors of evolution' debates, in which Spencer was a central participant. In applying his idea of organism–environment interaction to physical, biological, and social environments, Spencer produced a dichotomy that was taken to be relevant to both biology and psychology by late-nineteenth century writers. The shift from 'circumstances' to 'environment' also highlights the unificatory metaphysical work performed by the term 'environment'; there are alternative ways to partition the world outside the organism. It should be stated at the outset, however, that this shift is only obvious over longer timescales. For Spencer and his contemporaries, words like 'circumstances' and 'environment' were used as synonyms. But by the end of the nineteenth century, the ideas of environment and organism–environment interaction were ubiquitous, a change that has had implications for philosophical and biological thinking then and now.

The paper is divided into three main parts. In the next section, I will discuss Spencer's exposure to the idea of the force of circumstances in the 1840s. Charles Lyell, Alexander von Humboldt, and others emphasized the dependence of organisms on external conditions or circumstances, and were the source of Spencer's view that organisms change in response to changing conditions. I will then explore Spencer's growing interest in ideas of life in the early 1850s, and the relation of these ideas to the force of circumstances. Spencer's connection with George H. Lewes and other members of the intellectual circle around John Chapman deepened his knowledge of biology and renewed his interest in different conceptions of life. Finally, I will demonstrate that the writings of Comte, as interpreted by Chapman's circle, led directly to Spencer's definition of life as a dynamic correspondence between organism and environment in his *Principles of psychology* (1855). It was this book that popularized the term 'environment' and the notion of organism–environment interaction. In short, this paper will show how, in and through Spencer's work, the idea of an organism's conditions of existence was transformed into an abstract and portable dichotomy that swept through the scientific world—organism and environment.

2. The force of circumstances

Spencer was born and raised in Derby, in the Midlands of England. Although Spencer, in his autobiography (1904), plays down his Derby upbringing, Paul Elliott (2003) has shown that he was exposed to a wide variety of natural philosophical ideas during this period, and in particular to the evolutionary and developmental theories of Erasmus Darwin (Charles's grandfather). Spencer also discovered phrenological ideas in Derby, and a number of scholars have linked his later evolutionary philosophy to the thought of George Combe, the leading British phrenologist (Spencer, 1904, Vol. 1, pp. 200–203; Young, 1970, pp. 150–162; R. J. Richards, 1987, pp. 250–256; Elliott, 2003, pp. 22–23). However, the first hints of Spencer's idea of the correspondence between an organism and its environment came after his encounter with the ideas of

² As many social scientists have argued, linguistic organization is related in complicated and important ways to conceptual organization. See, for example Lucy (1992a,b).

Charles Lyell in the early 1840s; hence, this is where my story begins. In this section, I will explore how Spencer inherited the idea that organisms are constantly being affected by their external circumstances from Lyell, Jean-Baptiste Lamarck, Alexander von Humboldt, and the anonymous author of the *Vestiges of the natural history of creation* (Chambers, 1844). It was this idea of plural circumstances or conditions that preceded the unitary idea of an external environment.

From September of 1838 to April of 1841, while Charles Darwin was elsewhere quietly developing his theory of descent with modification, Spencer worked for the engineering office of the Birmingham and Gloucester Railway (Spencer, 1904, Vol. 1, pp. 140–186; Duncan, 1908, pp. 22–32).³ Because the railway often passed through Jurassic clay, there were always many interesting fossils ‘lying about’ in the railway office—in particular fossil ammonites (Spencer, 1904, Vol. 1, p. 175). According to Spencer, the collection and examination of such fossils led him to become quite interested in geology. One incidental but important result of this interest was his purchase of Charles Lyell’s *Principles of geology* in 1840 (ibid., p. 176).⁴ Lyell is normally credited with introducing Spencer to evolutionary ideas, specifically those of Lamarck (for example, R. J. Richards, 1987, pp. 267–268). Spencer himself plays up this aspect of Lyell’s influence, explaining in his autobiography that the section of the *Principles* criticizing Lamarck’s doctrine of the transmutation of species ‘produced the opposite effect to that intended,’ making him sympathetic to the idea that ‘organic forms’ had ‘arisen by progressive modifications, physically caused and inherited’ (Spencer, 1904, Vol. 1, pp. 176–177).⁵

But Spencer found more in Lyell than transmutation. Lyell’s critique of Lamarck also introduced Spencer to the importance of external circumstances. At the outset of the second volume of the *Principles*, Lyell (1832, pp. 1–2) explains that his first eleven chapters will deal with four main questions:

- 1) Are species permanent, or are they capable of being indefinitely modified?
- 2) Are the members of each species descended from one or many stocks?
- 3) How is the duration of a species limited by animate and inanimate conditions?
- 4) Are species successively exterminated, and new ones created in their place?

In his discussion of the first question, Lyell points out that Lamarck connects the transmutation of species to two basic principles: (a) life’s inherent ‘tendency to progressive advancement’ and (b) ‘the force of external circumstances’. Without variation in these circumstances, we would see a perfect, ‘graduated scale of being’; but because external conditions vary, leading to modifications of various sorts, the actual state of things is somewhat altered from this regular series (ibid., pp. 13–14; cf. Burkhardt, 1977, pp. 144–157).⁶ Lyell agreed with Lamarck that the force of external circumstances could result in the modification of organisms; he merely insisted that this modification had limits, and thus rejected transmu-

tation. Hence, whatever Spencer’s view on transmutation at this time, he was exposed to a key point of agreement between his two illustrious predecessors: organisms accommodate themselves to variation in external circumstances.

Lyell went even further than Lamarck in his discussion of these circumstances. In the work of the French naturalist, the term ‘circumstances’ included climate, temperature, habitat, and the mode of life of an organism (Lamarck, 1801, p. 13; 1809, Vol. 1, p. 238). In addressing his third question (see above), Lyell expands the reference of the term to include other organisms:

The stations of different plants and animals depend on a great complication of circumstances,—on an immense variety of relations in the state of the animate and inanimate worlds... In other words, the possibility of the existence of a certain species in a given locality, or of its thriving more or less therein, is determined not merely by temperature, humidity, soil, elevation, and other circumstances of the like kind, but also by the existence or non-existence, the abundance or scarcity, of a particular assemblage of other plants and animals in the same region. (Lyell, 1832, pp. 140–141; cf. Pearce, Forthcoming)

Thus, in Lyell, Spencer discovered a even richer portrait of the force of circumstances than he would have found in the works of Lamarck. The relevant circumstances of an organism, according to Lyell, were determined by its ‘immense variety of relations’ with its surroundings—a variety which included the presence and relative abundance of other organisms.

A few years after his reading of Lyell, in a series of letters published in *The Nonconformist*, Spencer stretched the term ‘circumstances’ even further. In the first letter, Spencer cites the phrenologist Sidney Smith, who emphasizes the importance of both physical and social circumstances in determining one’s character:

[Phrenology] teaches that there is no difference in susceptibility of advancement, betwixt the highest and lowest in the scale—that their sole distinction consists in the adventitious circumstances which have called their faculties into action. It bids us remember that the chance of geographical position—the accident of an accident—the fortuitous circumstances of climate, class, or society, produce all the difference betwixt vice and virtue. (Smith, 1838, p. 16; cf. Spencer, 1842a, p. 411 n.)⁷

But although Smith claims that phrenology will allow legislation to adapt itself to the weaknesses of humanity, which are after all in many cases the result of unfortunate circumstances, Spencer disagrees. He condemns ‘legislation that assists the people in their natural wants’, arguing that this very legislation would lead to degeneracy: ‘Surround [a creature] with circumstances which preclude the necessity for one of its faculties, and that faculty will gradually become impaired’ (Spencer, 1842b; cf. Smith, 1838, p. 22). Lyell had extended Lamarck’s conception of circumstances to include both inanimate and animate conditions; Spencer took one more step, adding to the mix the social circumstances created by legislative acts of government. This was no mere metaphor;

³ I am using the first British edition of Spencer’s *Autobiography* (1904). Note that the first American edition, which appeared in the same year, has a different pagination.

⁴ It is not clear which edition of Lyell’s *Principles* Spencer read. The first edition was published in three volumes in 1830, 1832, and 1833. Many more editions followed, the sixth of which appeared in 1840. However, the sections I will discuss were unchanged over the first six editions. In what follows, I will cite the first edition.

⁵ The words ‘transmutation’ and ‘development’ were often used at this time to refer to what we would now call evolution—the transformation of species into other species. For the changing meaning of the term ‘evolution’, see Richards (1992).

⁶ Philip Sloan (2005) claims that the ‘principal axis of Lamarckian transformism was that of a linear series, realized in time, moving from simpler forms up a scale of organization to more complex forms’. Sloan, presumably due to the worries of scholars like Pietro Corsi (1988, 2001), has added the following caveat in more recent versions of his *Stanford encyclopedia* article: although Lamarck later revised his idea of a linear series in response to the criticisms of Georges Cuvier, these revisions were not ‘developed in any theoretical extent by Lamarck himself, and [have] not had significant impact on the historical understanding of Lamarckianism’ (Sloan, 2008).

⁷ It might seem strange that phrenology, the study of localized faculties of the brain, would emphasize external circumstances. These circumstances were important to Smith because he thought that a child’s circumstances were the product of the actions of his or her parents, and that these actions also had physical cerebral effects that were subsequently inherited by the child (Smith, 1838, pp. 16–17). For other aspects of Smith’s influence on Spencer, see James Elwick (2003), pp. 46–48.

according to Spencer, the force of circumstances operated in a similar way regardless of whether these circumstances were physical, biological, or social (cf. La Vergata, 1995).⁸

Although Lyell and Lamarck had convinced Spencer of the importance of the force of circumstances, it was the anonymous *Vestiges of the natural history of creation*—or more precisely, a review of this work—that introduced him to the idea that internal form could be influenced by external circumstances (Chambers, 1844). As James Secord (2000) has shown, the *Vestiges* was nothing short of a popular sensation; it is thus unsurprising that Spencer mentions that he has heard good things about the book in a letter to his friend Edward Lott, written 18 March 1845 (Spencer, 1904, Vol. 1, p. 269). The *Westminster Review* gave notice of several editions of the *Vestiges*, in December of 1844 (1st ed.), March of 1845 (3rd ed.), and June of 1845 (4th ed.), finally reviewing the book in its September 1845 issue. That Spencer read this review is clear from yet another letter to Lott, in which he says that he has just ‘read a criticism on the work entitled “Kosmos” in *The Westminster Review*’ (Spencer, 1904, Vol. 1, p. 295). In a coincidence not yet flagged by Spencer scholars, Alexander von Humboldt’s *Kosmos* and the *Vestiges* were reviewed together in the *Westminster* by John Crosse; thus, in reading this review, Spencer was exposed to two influential works that championed the intimate association between organisms and their physical circumstances.⁹

Crosse actually spends more time on *Kosmos* than on the anonymous *Vestiges*. Humboldt, in this work, emphasizes the influence of physical circumstances on animals and plants—that is, the interconnection between geography, botany, and zoology. Crosse uses this as an excuse to launch into a defense of transmutation. He declares that ‘a genuine theory of development’ does not imply ‘a regular, undisturbed succession’ of organic types:

The undisturbed succession alluded to is only possible on the supposition of an equally simple development of terrestrial action. This action has been subject to periods of retardation and acceleration and waves of interference; and the organisms of which it is the outward condition must have been subject to the same. And yet there has been a progress from the simple to the complex... from an universal tropical climate to every shade of localized temperature; from large, preponderating masses of animal and vegetable life to the multiform varieties which differences in climate now render possible. There has been a gradation from the coral to the man. (Crosse, 1845, pp. 176–177; original emphasis)

Crosse thus insists that organic changes are dependent on terrestrial changes. A regular succession of organic forms is only possible given a regular succession of circumstances, for ‘organic structures and inorganic conditions are counterparts of each other’ (ibid.). He then argues that the geography of *Kosmos* and the transmutation of the *Vestiges* lead together to

the same practical conclusion, viz., that there is a law of successive development; that this law is not disproved by the fact of its shifting with the shifting circumstances of periods, but, on the contrary, established; that it is a law of nature, as of thought, to proceed from the simple to the complex; that as simpler

forms represent simpler conditions, and more complex forms more complex conditions, organisms that co-exist reveal this law as clearly as those which are successive. (Ibid., pp. 177–178; original emphasis)

Hence, the successive development of organisms from simple to complex mirrors a change from simple to complex conditions. The key principle of the *Vestiges*, according to Crosse, is thus completely consonant with Humboldt’s position: ‘Inorganic forces are the necessary links of organic changes’ (ibid., pp. 197; original emphasis). Given Crosse’s exuberance, it is not surprising that in his letter to Lott, Spencer mentions that Humboldt seems to have ‘a leaning to the “development theory”’ (Spencer, 1904, Vol. 1, p. 295). Crosse’s analysis, however, provided Spencer with more than just a generic theory of development; it introduced him to the idea of a development from the simple to the complex in which the simple forms correspond to simple conditions, and the complex to complex conditions. In reading this review, Spencer could not have missed its central theme: organisms are strongly dependent on external conditions, and changes in the latter produce changes in the former.

In the 1840s, Spencer encountered the idea of the transmutation of species in both Lamarck (via Lyell) and the *Vestiges* (via Crosse). But more importantly for our story, he discovered in his reading of Lyell, Crosse, and their interlocutors that organisms and species could be understood as transforming over time in response to dynamically changing conditions.¹⁰ By early 1849, Spencer had moved to London permanently, and found there a circle of intellectual radicals who would confirm this link between organisms and their external circumstances, leading him to inquire into the very nature of life. The influence of this circle is the topic of the next section.

3. Circumstances and the nature of life

Spencer left Derby for London in December of 1848 to assume a position as sub-editor of *The Economist*. His colleagues at the newspaper were not opposed to the idea of transmutation, as evidenced by a positive review of a book praising the theological implications of the *Vestiges*: ‘if a man could invent a lathe which at the end of a short time would turn out complete steam-engines, he would be considered a greater genius than if he had, as at present, to make steam-engines whenever he requires them’ (*Literature*, 1849, p. 184).¹¹ More importantly, however, the office of *The Economist* was across the street from 142 Strand, one of the most radical addresses in Victorian London (Ashton, 2006). This was the home of the bookseller John Chapman—at Chapman’s soirées, Spencer met religious radicals such as Francis W. Newman and James A. Froude and future friends such as George H. Lewes and Marian Evans, better known as George Eliot (Spencer, 1904, Vol. 1, pp. 347–348). In this section, I will examine how Spencer became interested in ideas about the nature of life, and in how these ideas were connected to external circumstances. These new interests were shaped by his interaction with those in the circle around Chapman from 1849 to 1852.

Like Spencer, the intellectuals of the Chapman circle were influenced by the ideas of the anonymous *Vestiges of the natural history*

⁸ Spencer’s suggestion that there are no basic differences between an organism’s relation to biological circumstances on the one hand, and to psychological and social circumstances on the other, would later infuriate psychologists such as William James.

⁹ For the three preliminary notices, see ‘Miscellaneous notices: Philosophy and science’ (1844, 1845a,b). The anonymous *Westminster Review* article is attributed to John Crosse by Secord (2000), p. 133. John’s father Andrew, who apparently spontaneously produced unknown insects by applying an electric current to various chemical solutions, is mentioned in the *Vestiges* (Chambers, 1844, p. 185).

¹⁰ This dynamic outlook was also characteristic of another author whom Spencer read in the 1840s, namely Ralph Waldo Emerson: ‘The new continents are built out of the ruins of an old planet; the new races fed out of the decomposition of the foregoing’ (Emerson, 1841, p. 304; cf. Spencer, 1904, Vol. 1, pp. 242–243).

¹¹ Spencer was not responsible for the ‘Literature’ section (Spencer, 1904, Vol. 1, p. 341).

of creation (1844). Francis Newman, for instance, reviewed the *Vestiges* in the very first issue of Chapman's journal *Prospective Review*.¹² After arguing that 'the doctrine of Materialism, if it be ever so true, ought not to affect any doctrine of morality or of religion', Newman begins an analysis of what the anonymous author 'modestly styles his "Hypothesis"', viz., 'the birth of one species out of another' (Newman, 1845, pp. 36, 66). He agrees with *Vestiges* that 'a change of physical circumstances' is necessary for species transmutation:

Let us, for instance, suppose the bed of a sea to be slowly upheaved, so as to bring, in the course of many generations, a gradual increase of light to the animals at the bottom; a great change in the species might follow, so as to disable us from recognizing their identity. The result would be increased by a change of temperature. (Ibid., pp. 67–69)

Thus drastic changes in physical conditions, according to Newman and the author of the *Vestiges*, are accompanied by corresponding changes in species exposed to those conditions. It is certainly true, as Mark Francis suggests (2007, pp. 132–143), that Newman and other radical intellectuals had an important effect on Spencer's metaphysical views. But conversations at 142 Strand, as Newman's scientifically erudite review of the *Vestiges* demonstrates, would also have confirmed Spencer's sense of the importance of the link between organic form and external circumstances.

Spencer's first major work, *Social statics: Or, the conditions essential to human happiness specified, and the first of them developed*, was published by Chapman in 1851. This book continued the themes of *The proper sphere of government* (see above), developing a theory of morality and progress that depended on the idea of a harmony between organisms and their circumstances—physical, biological, and social. It also demonstrated a new concern with the nature of life. In the book, Spencer ties biological and social progress to Samuel Taylor Coleridge's idea of life as 'the tendency to individuation' (Coleridge, 1848, p. 49, quoted in Spencer, 1851, p. 436; original emphasis). According to Coleridge (ibid., pp. 42–50), individuation involves 'unity in *multeity*', that is, the separation of parts combined with the connection of those parts in a whole. This idea appealed to Spencer because it resonated with the progressive account of creation championed by comparative anatomists like Thomas Rymer Jones and Richard Owen, who sought 'to arrange the grand divisions of the animal world in conformity with progressive development' (Jones, 1841, p. viii).¹³ For Spencer, building on Jones and Coleridge, the entire animal series—from barely living sponges to colonial polyps to social humans—could be read as a chart of increasing individuation of both organisms and their parts.¹⁴ The argument of *Social statics* (1851, p. 78) is built around the fundamental law that 'every man may claim the fullest liberty to exercise his faculties compatible with the possession of like liberty by every other man', and Spencer, at the end of his dis-

ussion of the animal series, says that this is the moral law 'under which individuation becomes perfect' (ibid., p. 440).

To support this bold claim, Spencer combines the account of the force of circumstances he encountered in Lyell and Crosse (see above) with Coleridge's idea of life. In the final section of *Social statics*, Spencer tackles dynamics for the first time, explaining 'the forces by which society is advanced towards perfection' (ibid., p. 409). At issue is the transition between 'the aboriginal man' in the state of nature and 'the ultimate man' in the 'perfect social state' (ibid., pp. 409–410). All social problems, according to Spencer, stem from the clash between the aboriginal constitution that still persists in many and the 'new circumstances' presented by the modern state (ibid., p. 413). But, as we have seen, a clash between constitution and circumstances should inevitably lead to a modification of constitution—why has this not happened?

The answer is that the new conditions to which adaptation has been taking place have themselves grown up but slowly. Only when a revolution in circumstances is at once both marked and permanent, does a decisive alteration of character take place. (Ibid., p. 414)

Thus, social and political revolutions, for Spencer, are directly connected to revolutions in social and political circumstances. The relevant circumstances for modern humans are not physical or biological, but social. This is why Spencer famously compares society to an organism, equating the ultimate man in the perfect social state with the highest expression of Coleridge's tendency to individuation. As James Elwick (2003) has shown, Spencer endorsed a democratic vision of the social organism: ultimately, the interests of the parts of this organism (humans) come to coincide with the interests of the organism as a whole (society).¹⁵ In *Social statics*, Spencer combines Coleridge's progressive account of life with a more complex view of humans' social circumstances. Civilization is 'a development of man's latent capabilities under the action of favourable circumstances', and the ultimate tendency of human progress is toward the perfect social state populated by perfectly free individuals—for Spencer, 'no one can be perfectly free until all are free' (Spencer, 1851, pp. 415, 456).

Social statics quickly caught the attention of the other members of Chapman's circle. G.H. Lewes reviewed the book in his radical weekly newspaper *The Leader* in March and April of 1851, and Marian Evans (aka George Eliot) wrote to Charles Bray on 4 October that she had met a 'Mr. Herbert Spencer who has just brought out a large work on 'Social statics', which Lewes pronounces the best book he has seen on the subject', adding 'You must see the book if possible' (Lewes, 1851b; Haight, 1954–1978, Vol. 1, p. 364). Lewes and Spencer had met in the spring of 1850, but the two did not become close until the following year, when they began going for long walks and discussing the mysteries of biological development (Duncan, 1908, p. 63). Even prior to his acquaintance with Spencer, Lewes favored the idea of a 'gradual evolution of life',

¹² Secord (2000), pp. 204–205, points out that Newman's authorship of the review was known in the Unitarian community. The publication that put Chapman on the map was a translation of David Strauss's *Life of Jesus* (1846). Many assumed that it was translated by Newman, author of *The soul, her sorrows and aspirations* (1849) and *Phases of faith* (1850), although the actual translator was Marian Evans, aka George Eliot (Ashton, 2006, pp. 22–26).

¹³ Spencer, in *Social statics* (1851), pp. 436–441, cites Jones's *General outline of the animal kingdom* (1841)—dedicated to Richard Owen—to illustrate Coleridge's idea of life. He also quotes Owen's Hunterian Lectures of 1849, *On the generation and development of the invertebrated animals*, which were serialized in the *Medical Times* beginning 14 April 1849 (Spencer, 1851, pp. 448–453). James Elwick (2003), p. 49, suggests that Spencer is citing Owen's *On parthenogenesis* (1849b); this is incorrect, for the quoted passages are from Lecture VII, and only the first two lectures of the 1849 series appear in *On parthenogenesis* (see Owen, 1849a, p. 616). Spencer actually knew Jones personally, for he was once a pupil of Spencer's father in Derby (Spencer, 1904, Vol. 1, pp. 66, 106).

¹⁴ This demonstrates that although Spencer did not encounter Henri Milne-Edwards's idea of the physiological division of labor until the autumn of 1851, he was already thinking along similar lines in 1850 (Milne-Edwards, 1851; Spencer, 1899, p. 542; 1904, Vol. 1, p. 376. On this idea more generally, see Limoges, 1994).

¹⁵ Robert Richards (1987), p. 257, claims that this vision may have been due in part to James Wilson, the editor who hired Spencer to work at *The Economist*. As his autobiography attests (1904, Vol. 1, p. 330), Spencer was aware of Wilson's book *The influences of the Corn Laws*, in which the following passage appears: 'We adhere closely to what we believe the only true theory on national interests:—That nothing can possibly be favourable to the whole that is detrimental to a part, and that nothing can be detrimental to one portion that is favourable to another portion' (Wilson, 1839, pp. 49–50; cf. Gordon, 1955, pp. 466–467). The idea of the social organism does not seem to have appeared in the pages of *The Economist* until 1853—in a review of G. H. Lewes's book on Comte, not coincidentally ('Literature', 1853, p. 1386).

as one anonymous column in *The Leader* put it ('Development theory and Mr. H. Miller's book', 1850).¹⁶ That Lewes tentatively supported the idea of transmutation is clear from his response to a vicious attack on the *Vestiges* by Adam Sedgwick. He accuses Sedgwick (1850) of substituting insult for argument, calling him 'a great master of the Vituperative Syllogism' (Lewes, 1850, p. 566). Spencer, in the person of Lewes, had found an ally in Chapman's circle, someone who shared his belief in the force of circumstances and the resultant modification of organic forms.

In *The Leader* for 15 October 1851, Lewes reviewed a debate between Charles Lyell and Richard Owen, presenting along the way the two-factor theory of biological organization that would later be taken up by Spencer.¹⁷ The argument between Lyell and Owen concerned the claim, endorsed by Spencer in *Social statics*, that the animal series reveals a progressive advancement in complexity—what Spencer saw, following Coleridge, as a more and more perfect expression of the tendency to individuation (see above). In March and April of 1851, Spencer had encountered first-hand Owen's viewpoint in the anatomist's Hunterian lectures *On comparative osteology*, which argued that skeletons from fish to apes could be seen as a progressive series of modifications of a vertebrate archetype (Owen, 1851b, p. 334; Spencer, 1899, p. 541; 1904, Vol. 1, p. 368).¹⁸ Lewes, recently befriended by Spencer, took up Owen's cause against Lyell, who had attacked the doctrine of Owen and others 'according to which a gradual development in the scale of being . . . can be deduced from palaeontological evidence' (Lyell, 1851, p. xxxiii). Owen, in his response, attributes this progression in complexity to changes in circumstances:

In relation to the circumstances in which they lived, palaeozoic fishes were as perfect as their successors; but, in comparison with these successors, they were 'less fully developed', and the state of their world may be inferred to have differed pro tanto [i.e., to that extent] from the state of ours. (Owen, 1851a, p. 426, quoted in Lewes, 1851a, p. 996)¹⁹

Lewes, in describing Owen's claim that a progressive advancement in complexity is consistent with organisms being perfectly adapted to their circumstances, takes the opportunity to chide the author of the *Vestiges* for his one-sided view: 'the ordinary conception of the Development hypothesis', he writes, 'treats organization as if it were in some sort independent of external conditions, and not the resultant of two factors—Life and Circumstance (to use broad familiar terms)' (Lewes, 1851a, p. 996; original emphasis). As we will see in the next section, Lewes inherited this two-factor view from Auguste Comte; for the moment, it suffices to

say that Lewes's views on organization, progression, transmutation, and the force of circumstances were consonant with and perhaps even more sophisticated than Spencer's at this time.

In his review of the Owen–Lyell debate, Lewes also points out that the basic problem with Lyell's critique is a 'want of precise notions about Life' (ibid.). As we have seen, Spencer had already embraced Coleridge's idea of life as a tendency to individuation in *Social statics*. Late in 1851, Chapman unintentionally introduced Spencer to another important account of life, namely, that of the physiologist William B. Carpenter. Spencer read the third edition of Carpenter's *Principles of physiology* (1851) at Chapman's request, for a review of the book was to be included in the first issue of Chapman's newly acquired *Westminster Review* (Spencer, 1904, Vol. 1, p. 384).²⁰ Early in 1852, Spencer began to write a longer review of the works of Carpenter and others for the April issue of the *Westminster* (ibid., Vol. 1, p. 388). In this article, which focuses on a new theory of population, Spencer sets himself the preliminary task of developing a 'clear idea of the nature of Life itself' (Spencer, 1852a, p. 471). Carpenter, in his article on 'Life' for Todd's *Cyclopaedia of anatomy and physiology* and in the third chapter of his *Principles of physiology*, both of which were part of Spencer's review, had emphasized the importance of the external conditions of life, lamenting that the 'dependence of life on external stimuli has been completely overlooked by the advocates of the vital principle' (Carpenter, 1839–1847, p. 147). Strangely, however, Spencer's definition of life excludes external factors: 'Life may be defined as—the co-ordination of actions' (Spencer, 1852a, p. 472; original emphasis). Thus, instead of being swayed by Carpenter, Spencer continued to follow Coleridge in focusing on internal factors like the number and variety of actions coordinated by individual organisms (ibid.). In 1852, then, Spencer had still not joined his account of the force of external circumstances with his picture of life, despite having revised the latter to some extent. Both Lewes and Carpenter, however, were pushing him in this direction.

It is difficult to overstate the importance of Chapman's circle to Spencer's intellectual development in this period. Not only were many of Chapman's companions already interested in the influence of external circumstances on organic form, but Chapman himself published Spencer's first major work, *Social statics*. And although Spencer (1904, Vol. 1, p. 376) attributes Lewes's 'awakened interest in scientific inquiries' to their walks together late in 1851, Lewes had by that time written an analysis of the Lyell–Owen debate, having already defended aspects of the *Vestiges* the previous year (see above)—the influence was thus obviously reciprocal. Moreover, although Spencer did not encounter Karl Ernst von Baer's

¹⁶ Although Paul White (2002), p. 75, claims that Lewes wrote the regular 'Progress of science' column in *The Leader*, the 'Development theory' article, part of this series, is cancelled in pencil in Lewes's own volume of clippings from the newspaper, indicating that he did not write it. The following articles are not cancelled, confirming Lewes's authorship: Lewes (1850, 1851b, 1853b,c). I thank Ellen Doon of the Beinecke Library at Yale University for providing me with this information.

¹⁷ There is disagreement in the literature as to the authorship of this article. Postlethwaite (1984), p. 191, and Ashton (1991), p. 301 n. 11, attribute the article to Lewes, while R.J. Richards (1987), pp. 269–270, and Perrin (1993), p. 170, attribute it to Spencer. Regarding Lewes, although Ashton (1991), p. 97, points out that he was responsible for the 'Literature' section of the paper, this article does not appear in his volume of clippings from *The Leader*—but strangely, there are no clippings from 19 July 1851 to 1 January 1853, so this is not definitive (Ellen Doon, Beinecke Library, pers. comm.). Regarding Spencer, Richards (pers. comm.) does not recall his evidence for the attribution, and although Spencer does discuss his contributions to *The Leader* in the *Autobiography* (Spencer, 1904, Vol. 1, pp. 385–386), this article is not mentioned. (Perrin may simply have been following Richards's attribution.) I think Lewes is the likelier candidate for internal, textual reasons: first, there is an offhand reference to Auguste Comte in the first paragraph, and Spencer knew little of Comte until the following spring (Spencer, 1904, Vol. 1, p. 398), second, although 'Lyell and Owen' defends aspects of the *Vestiges*, Spencer does not mention this work in any of his other articles—not even in 'The development hypothesis' (Spencer, 1852b), published anonymously the following March in *The Leader*—whereas Lewes mentions it often; and third, the phrase 'Life and Circumstance' (note the singular, never employed by Spencer) used in the article parallels Comte's opposition between organism and medium, discussed the following year by Lewes in his exposition of Comte's philosophy (Lewes, 1851a, p. 996; 1852a, p. 666). I will discuss this third point further below.

¹⁸ For Owen's account of the vertebrate skeleton, see Owen (1848). The dates of many of the 1851 lectures can be found in the *Medical Times*, 23 (January–June 1851), pp. 220–467. Adrian Desmond (1982), p. 31, incorrectly reports that Spencer attended Owen's 1852 lectures. For a list of Richard Owen's annual Hunterian lectures from 1837 to 1855, see Rupke (1985), p. 243.

¹⁹ The article is attributed to Owen by Lewes (1851a) as well as by the *Wellesley index to Victorian periodicals*. Owen had a complex relationship with ideas of transmutation: see the discussions of Adrian Desmond (1982), pp. 29–37, Evellen Richards (1987), and Ron Amundson (2005), pp. 76–106. See also Darwin's letter to J. D. Hooker of November 1851 (Darwin, 1851).

²⁰ As Rosemary Ashton (2006), p. 119, has described, Spencer and Marian Evans, who was basically editing the *Westminster Review* for Chapman, were jointly responsible for the section on 'Contemporary literature of England', where the review of Carpenter appeared ('Contemporary literature of England', 1852, pp. 274–275).

claim that a 'heterogeneous or special structure arises out of one more homogeneous and partial' until his reading of Carpenter (1851, p. 576; original emphasis), Lewes was already claiming at the time that 'Nature uniformly proceeds from the simple to the complex, from the more general to the more specific organization' (1851a, p. 996; original emphasis).²¹ While Spencer became interested in notions of life after reading Coleridge in 1850, his discussions with Lewes and reading of Carpenter in 1851–1852 likely kept him focused on this topic. Carpenter argued that a general account of life must not exclude external stimuli, and Lewes insisted that organic form was 'the resultant of two factors—the organism and the external conditions', thinking this important enough to repeat twice in the same review (*ibid.*). In the next section, we will discover what prompted Spencer's conversion to this two-factor theory.

4. Organism–environment correspondence

Spencer first encountered Comte's work, albeit indirectly, in the autumn of 1851, when he read Lewes's *Biographical history of philosophy* (Spencer, 1904, Vol. 1, p. 392; Duncan, 1908, p. 418). This book culminates in Lewes's account of Comte's philosophy of science, the description of which could just as easily fit Spencer's project:

The new philosophy which, under the title of positive, M. Comte proposes to create . . . is destined to put an end to this anarchy, by presenting a doctrine *positive*, because elaborated from the sciences, and yet possessing all the desired *generality* of metaphysical doctrines without possessing their vagueness, instability, and inapplicability. (Lewes, 1845–1846, Vol. 4, p. 248; original emphasis)

In the spring of 1852, as Spencer reports in his autobiography, Marian Evans (aka George Eliot)—with whom he was soon to be romantically linked—induced him to read the 'Exposition' of Comte's *Cours de philosophie positive* (Comte, 1830, pp. 1–115).²² Spencer's French was not up to the task, but he did understand enough to realize that he disagreed with Comte about the classification of the sciences, a fact that would eventually play a role in his article 'The genesis of science' (Spencer, 1854; 1904, Vol. 1, p. 398). Luckily, given Spencer's poor command of foreign languages, Lewes began in April of 1852 to publish a serial account of 'Comte's positive philosophy' in the 'Portfolio' section of *The Leader*.²³ In his autobiography, Spencer mentions that he read Lewes's interpretations of Comte as they appeared; he also read Harriet Martineau's abridged translation of Comte when it was published in 1853 (Spencer, 1904, Vol. 1, pp. 444–445; cf. Haight, 1954–1978, Vol. 2, p. 140).²⁴ In Comte, Spencer found a new conception of life centered on the correspondence between organism and environment—this conception formed the core of Spencer's *Principles of psychology*.

As T. R. Wright (1986) has shown, Comtean ideas spread through Britain like an epidemic; like many, Spencer resisted, but he was not immune. Even in Spencer's own time, his readers noted the connection between his ideas and those of Comte. The link is perhaps most obvious in the case of *altruism*, analyzed extensively by Dixon (2008): the word was coined by Comte, and figured often in the work of both Spencer and Lewes. Because Spencer used Comtean terms like 'altruism' and 'sociology', he often had difficulty convincing people that he was not a disciple of the French philosopher. As many historians have discussed, the positivist Frederic Harrison called Spencer a Comtean in 1884, leading to a public exchange in which Spencer reasserted the independence of his thought (Eisen, 1967; Jones, 1970; Postlethwaite, 1984, pp. 39–52; Wright, 1986, pp. 163–168; Taylor, 2007, pp. 43–56; Dixon, 2008, pp. 202–206). However, no one has investigated the influence of Comte's biological writings on Spencer. This is likely because Comte, like Spencer, is best known for his sociological rather than his biological views (but see Canguilhem, 1958).²⁵ As we will see, Spencer inherited the idea of organism–environment interaction directly from Comte.

The word '*milieu*' in Comte's work became the word 'environment' in Spencer's. Lamarck, whom Spencer had encountered in Lyell's *Principles*, used '*milieux*' (media) only in the plural, to refer to surrounding fluids like water and air. It was Comte who first used '*milieu*' in the singular to mean an organism's external circumstances more generally, coming close to 'a dialectical conception of the relations between organism and *milieu*' (Canguilhem, 1952, pp. 163–165; cf. Braunstein, 1997).²⁶ In Lesson 40 of the third volume of the *Cours de philosophie positive*, 'Philosophical Considerations on the Whole of Biological Science', Comte is quite clear about the important role of the *milieu* in his thinking. He dismisses Xavier Bichat's definition of life—'*Life is the sum of the functions by which death is resisted*'—with the following point, as paraphrased by Lewes and translated by Martineau:

if Bichat had only steadily considered the indispensable co-operation of the medium or surrounding circumstances in which an organization is placed, with the organization itself, if he had considered how a slight change in external conditions is sufficient to *revive* a dying animal or to *destroy* a living animal, he could never have propounded such a definition, for he would have seen that so far from organic bodies being independent of external circumstances they are more and more dependent on them as their organization becomes higher, so that *organism* and *medium* are the two correlative ideas of life—(Lewes, 1852a, p. 666; original emphasis; cf. Lewes, 1853a, p. 167)

The irrationality of this conception consists especially in its suppressing one of the two elements whose concurrence is neces-

²¹ See also Lewes's 'Goethe as a man of science': for Goethe, 'the march of Nature was always from the simple to the complex, from the homogeneous to the heterogeneous' (Lewes, 1852c, p. 268). Spencer almost certainly read this essay, as his 'Philosophy of style' (1852c) appeared in the same issue (October). Although Spencer does not employ this formulation in 'The development hypothesis' (1852b), he does use it in the *Principles of psychology* (1855), p. 143, and it is the core of his law of evolution in *First principles* (1862).

²² Evans's letters indicate that she and Spencer often attended the theatre together in the spring of 1852: Rossini's opera *William Tell* on 1 April; Lewes's play *The chain of events* (which she disparaged) on 17 April; and Donizetti's opera *The martyrs* on 24 April (Haight, 1954–1978, Vol. 2, pp. 16–22). For the details of this complex relationship, see Ashton (1991), pp. 132–136; (2006), pp. 115–116, and Francis (2007), pp. 57–66.

²³ Thomas H. Huxley, already a friend of Spencer by this time, reviewed the book version, *Comte's positive philosophy* (Lewes, 1853a), noting Lewes's advocacy of the development hypothesis and disparaging his scientific credentials (Huxley, 1854, pp. 254–257). On the tensions between Lewes and Huxley, see Elwick (2007), pp. 151–159.

²⁴ Harriet Martineau was the sister of the Unitarian James Martineau. She was also a member of the Chapman circle: Chapman published her and H.G. Atkinson's atheist *Letters on the laws of man's nature and development* (1851), as well as her translation of Comte (1853). Incidentally, Harriet Martineau was also suspected of being the author of the *Vestiges*. Although she was not, she was certainly enthusiastic about Darwin's *Origin of species* when it was published (Secord, 2000, p. 461; Browne, 2002, p. 92). For more on Martineau's connections with the Chapman circle, see Ashton (2006).

²⁵ Although John Greene (1959) has discussed the relation between biology and social theory in the work of both Comte and Spencer, he has not explored the relation between these two thinkers. For Comte's influence on Lewes and Evans, see Ashton (1979, 1991, pp. 45–50).

²⁶ As both Canguilhem (1958) and Annie Petit (1997) have demonstrated, Comte's main source of biological ideas was Henri-Marie Ducrotay de Blainville, who devoted a section of the third volume of his *Cours de physiologie générale et comparée* to 'the action of general external modifiers on the organism' (1833, p. 381). Blainville's influence is evident in the third volume of Comte's *Cours*, which appeared in 1838.

sary to the general idea of *life*. This idea supposes, not only a being so organized as to admit of the vital state, but such an arrangement of external influences as will also admit of it. The harmony between the living being and the corresponding *medium* (as I shall call its environment) evidently characterizes the fundamental condition of life; whereas on Bichat's supposition, the whole environment of living beings tends to destroy them. (Comte, 1853, p. 360; original emphasis; cf. Comte, 1838, pp. 288–289)

After reading these passages, Spencer must have been struck by several aspects of Comte's account: first, his definition of life, like Carpenter's, included an explicit consideration of the organism's circumstances; second, the relation between the organism and its environment was characterized as a correspondence, and as 'the fundamental condition of life'; and third, Comte employed the singular terms 'medium' and 'environment' (the latter only in Martineau's translation), rather than the plural terms 'circumstances' and 'conditions'. All three of these ideas would come to play important roles in Spencer's new definition of life in the *Principles of psychology* (1855).

Where did Martineau get the term 'environment', which appeared only in her parenthetical insertion with no counterpart in the original French? Like Lewes and many other members of Chapman's circle, Martineau was acquainted with the essayist and historian Thomas Carlyle and his works.²⁷ Carlyle appears to have coined the word 'environment' in 1828 in a pair of reviews of Johann Wolfgang von Goethe's collected works. These articles were published in the *Foreign Review*, and the second reveals that he may have coined the word as a translation of a particular German term: Carlyle uses the phrase 'environment of circumstances' to translate Goethe's '*Umgebung*', a singular term meaning 'surroundings' (Carlyle, 1828a, p. 98; Goethe, 1814, p. 332).²⁸ Carlyle used 'environment', albeit infrequently, to refer to the generalized circumstances and situation of developing individuals or texts. He employed the term several times in his well known book *Sartor resartus*, first published serially in 1833–1834: for example, 'To each is given a certain inward Talent, a certain outward Environment of Fortune' (Carlyle, 1834, p. 191). Although Spencer did read *Sartor*, he did not begin using the word 'environment' until after his reading of Comte (Spencer, 1904, Vol. 1, pp. 230–231). Thus, the linguistic trajectory is as follows: Carlyle coins the English 'environment' in 1828, possibly as a translation of the singular German word '*Umgebung*'; in 1853, Martineau either borrows the term from Carlyle or independently coins it to translate the singular French word '*milieu*'; Spencer reads Martineau's translation of Comte and goes on to popularize the word 'environment' with his *Principles of psychology* (1855), where it appears no fewer than 185 times.²⁹

As mentioned, however, Spencer got more than just a word from Martineau and Comte. He also inherited a new idea of life that was more akin to that of Lewes and Carpenter than to his own 1852 definition (see above). As Comte mentions in a footnote, partially quoted by Lewes, '*milieu*' is a 'new expression' that he is using to designate 'the whole of the surrounding circumstances necessary to the existence of the organism' (Lewes, 1852b, p. 688; 1853a, p. 173; cf. Comte, 1838, p. 301 n.). Neither the organism nor the environment is more important, for 'the idea of life supposes the mutual relation of two indispensable elements,—an organism, and a suitable medium or environment' (Comte, 1853, p. 363; cf. 1838, p. 301). Comte even recommends the pursuit of a 'general theory of organic media, and of their action upon the

organism, abstractedly regarded' (ibid., p. 365; cf. 1838, p. 308). This is the advantage of a singular term like 'environment'—it is a whole variety of circumstances, but 'abstractedly regarded'. Harriet Martineau deserves some credit here, for it is her translation that introduced the word 'environment' to translate '*milieu*', allowing us to speak for the first time of 'the mutual relations of the organism and its environment,' a phrasing that does not even appear in Comte's original text (ibid., p. 368; cf. 1838, p. 324). This abstract dichotomy of organism and environment, a result of Martineau's fortuitous translation, would dominate Spencer's *Principles of psychology* (1855).

The *Principles*, according to Spencer's typically modest assessment in a letter to his father, written while working on the book, would 'ultimately stand beside Newton's *Principia*' (Duncan, 1908, p. 75). It certainly was an influential text. The standard view of Spencer's *Psychology* is that it 'united the association psychology with the theory of evolution' to produce a kind of 'evolutionary associationism' (Young, 1970, pp. 169–180; cf. Rylance, 2000, pp. 212–218). This is an accurate but incomplete assessment. Spencer's most explicit formulation of so-called evolutionary associationism appears only late in the book, in the section on 'The Law of Intelligence'—this law states that intelligence is proportional to the correspondence between 'connections in consciousness' and 'connections in the environment', which he explicitly calls 'a generalization of the facts grouped under the head of "association of ideas"' (Spencer, 1855, p. 517). But Spencer's definition of intelligence is only a specific version of his definition of mind, which is a specific version of his definition of life. It is this latter definition that provided the foundation for Spencer's psychological theory.

Recall that in 1852, Spencer had defined life as the coordination of actions. In the *Principles*, he looks back on this definition as 'answering to the facts with tolerable precision' but 'omitting an essential particularity of vital changes in general' (ibid., pp. 354–356). What is this particularity? The answer is in the title to the next chapter: 'The Correspondence between Life and its Circumstances' (ibid., p. 367). Spencer points out that 'the changes or processes displayed by a living body, are specially related to the changes or processes in the environment', and introduces the term 'correspondence' as the word that most adequately comprehends 'all forms of this relation between the organism and its medium' (ibid., p. 373). Comte's terms 'medium' and 'correspondence', not to mention the word 'environment', indicate that Spencer has modified his earlier definition of life in response to his encounter with Martineau's translation of the *Cours*. By the end of the chapter, we learn that 'the broadest and most complete definition of life [is]—*The continuous adjustment of internal relations to outer relations*' (ibid., p. 374; original emphasis). Spencer's new definition of life thus explicitly includes external conditions, which are continuously tracked by internal states. This adjustment, of course, relates directly to evolution, both of the embryo in its development and of the adult organism that 'becomes better adapted to its conditions' (ibid., p. 375).

Spencer's definition applies not just to organisms but to groups of organisms, for the transformation and evolution of species involves an adaptation to new aspects of the environment. For example, the definition provides an explanation for the progressive increase in complexity that Owen found in the fossil record: 'life will be perfect only when the correspondence is perfect' (ibid., p. 376). Thus, changes in the lowest organisms only correspond to

²⁷ Lewes in fact introduced Spencer to Carlyle (Spencer, 1904, Vol. 1, pp. 379–380; cf. Baker, 1976). For the relationship between Carlyle and Lewes, see Haight (1976).

²⁸ The *Oxford English dictionary* cites this use—in 'Goethe' (1828a), published in September—but gives the date incorrectly as 1827. Carlyle's first use of the term was in 'Goethe's *Helena*' (Carlyle, 1828b), published in January. Etymologically, the word derives from the French verb *environner*, meaning 'to environ' (the English word 'environ' was in common use well before the nineteenth century).

²⁹ Spencer (1855) is available for download as a PDF at the *The online library of liberty* website, <http://oll.libertyfund.org/>. The word 'evolution', incidentally, appears fifty-six times.

the most common changes in the environment, and progress consists in developing the ability to respond to more infrequent environmental perturbations (ibid., pp. 377–378). Likewise, the lowest forms of life are found in simple environments, whereas higher forms reside in more complicated environments (ibid., p. 385). However, ‘simple’ and ‘complicated’ are relative to the organism in question: because they move through the water, only occasionally encountering food, protozoans live in a more complicated environment than yeast, although the latter’s surrounding medium is more complicated from our point of view (ibid., p. 388). Similarly, plants only adjust to general environmental factors like heat and light, whereas animals respond to these as well as to other, more specific changes (ibid., p. 391). In addition to becoming more complicated, the correspondence between the organism and its environment extends in both space and time with the progressive advancement of life (ibid., pp. 394–422). And finally, because Spencer believes that bodily and mental life are divisions of life in general, his definition of life as the adjustment of inner to outer relations is meant to apply in both physiology and psychology (ibid., pp. 351, 482). Thus, Spencer’s idea of environment, like his earlier concept of circumstances, was biological, psychological, and social at the same time.

It should be noted that Spencer draws no distinction between the terms ‘environment’ and ‘circumstances’, which he uses as synonyms in the *Principles*. Moreover, other thinkers, like Darwin, got along fine without the new word ‘environment’: in the *Origin*, he prefers ‘circumstances’, and does not use ‘environment’ until the second edition of *The variations of animals and plants under domestication* (Darwin, 1875, Vol. 2, p. 281; cf. 1868, Vol. 2, pp. 290–291). Thus, the metaphysical implications of the shift from ‘circumstances’ to ‘environment’, of which more below, are implications for later philosophers and biologists, not for Spencer himself.

Spencer’s account of life and mind in his *Psychology* is essentially a combination of the approach of *Social statics* with Comte’s claim that the co-relation between organism and environment is the fundamental aspect of life. The *Principles*’ presentation of life as the maintenance of the correspondence between organism and environment also has the advantage of directly supporting the progress in complexity that has characterized the history of life, as presented so convincingly by Lewes and Owen. When Spencer describes how organism–environment correspondence can increase along multiple axes, he seems almost modern—he even argues that the nature of the environment is relative to the organism being considered. However, as Peter Godfrey-Smith has argued, Spencer’s approach is avowedly ‘externalist’, meaning he explains the properties of organisms by appealing to the properties of their environments (Godfrey-Smith, 1996, pp. 66–99). Comte, on the other hand, stresses the fact that as an organism becomes more complex, its power ‘in modifying the influences of the medium rises in proportion’: for instance, ‘[Man] has a superior power of reacting on the surrounding system’ (Comte, 1853, p. 361; cf. 1838, p. 291).³⁰ It is hard to imagine Spencer disagreeing with this, but he could simply reply that increased control over the environment is itself an improved correspondence; after all, such control is surely proportional to what Spencer calls ‘quantitative prevision’, the hallmark of scientific thought, which is ‘distinguished by the relatively high speciality of the correspondences that it achieves’ (Spencer, 1855, p. 435). Nevertheless, later attacks on Spencer, like those of William James, focused on this aspect of his work—Spencer’s version of organism–environment correspondence seemed to eliminate the agency that psychologists held dear (James, 1878).

Table 1

Author	Term	Domain
Lamarck	<i>milieux</i>	Fluid
Lamarck	<i>circonstances</i>	Physical
Lyell	circumstances/conditions	Physical, Biological
Humboldt/Vestiges	circumstances/conditions	Physical
Comte	<i>milieu</i>	Physical, Biological
Spencer	circumstances/conditions	Physical, Biological, Social
Spencer	environment	Physical, Biological, Social

Spencer’s *Principles* popularized the term ‘environment’—but what are the conceptual implications of this apparently minor linguistic adjustment? Although Spencer and others often treated words like ‘environment’ and ‘circumstances’ as synonyms, the shift from a plural to a singular term had metaphysical and methodological implications. In terms of metaphysics, the successive transitions from individuated particular factors (e.g., climate), to a general plural term (e.g., ‘circumstances’), to a general singular term (e.g., ‘environment’), correspond to a progressive concealment of the different elements that make up the world outside the organism and the relations between these elements. This concealment, perhaps misleadingly, implies that the environment can be taken to be a single, unified cause—as in Darwin’s first use of the term, where he speaks of ‘the direct action of the environment’ (Darwin, 1875, Vol. 2, p. 281). However, the singular term ‘environment’, like ‘organism’, is an important heuristic for biologists, insofar as it gives them a way to talk about general causes without exploring the details of micro-level complexity (the term ‘natural selection’ is a parallel case). Hence, the word ‘environment’ does metaphysical work.

There are many ways to partition the world outside the organism; moreover, certain of its aspects are often systematically ignored: for instance, Lamarck’s ‘*circonstances*’ does not include other organisms, whereas Lyell’s ‘circumstances’ does. Table 1 demonstrates how the various terms divide up the world in different ways, and apply to different metaphysical domains.

The final two entries indicate that Spencer, even before he used the term ‘environment’, applied the same model to the physical, biological, and social domains. This highlights a second, methodological implication of the shift from ‘circumstances’ to ‘environment’. Spencer’s introduction of a singular term allowed the opposition of two unified, abstract entities, the organism and its environment. This abstraction made the dichotomy intellectually portable, for it remained agnostic about the reference of each of its terms. Subsequently, the organism–environment dyad became a standard conceptual tool in American biology, psychology, and philosophy (for example, Dewey, 1896).

The interaction between organism and environment also lay at the center of the debate over the ‘factors of evolution’ that exploded in the 1890s—a debate in which Spencer himself was a major player (Spencer, 1893; Weismann, 1893). In some sense, this debate was only possible because the environment could be seen as a cause, as in Darwin’s phrase ‘the direct action of the environment’ (Darwin, 1875, Vol. 2, p. 281). Spencer argued, against Weismann, that variations were directed or biased because of the influence of the environment, whereas Weismann claimed that the heritable germ-plasm was isolated from the environment. When J. M. Baldwin, C. L. Morgan, and H. F. Osborn independently discovered in 1896 what is now known as the ‘Baldwin Effect’ (ontogenetic changes allow survival until the appearance of corresponding phylogenetic changes), it was in large part because each

³⁰ Lyell (1832), p. 283, likewise, emphasizes the ‘powers of the organic creation in modifying the form and structure’ of the physical world, citing the example of coral reefs and anticipating modern accounts of ecosystem engineering.

of them emphasized that every organism is a product of ‘constitution + the environment’ (Osborn, quoted in Dyar, 1896, p. 141). Both the Spencer–Weismann dispute and the ‘Baldwin Effect’ have been discussed by modern biologists, and the problem of organism–environment interaction is still central to biological debates (Gould, 2002, pp. 197–208; Crispo, 2007; Lewontin, 1983; Erwin, 2008). The legacy of Spencer’s idea thus continues today.

5. Conclusion

In this paper, I have used the intellectual trajectory of Herbert Spencer to present a new picture of the rise of the idea of organism–environment interaction in the mid-nineteenth century. Spencer effectively introduced the term ‘environment’ and the concept of organism–environment interaction to the English-speaking world. In this, he was revolutionary—Darwin did not use the word until 1875. Ironically, however, Spencer is usually remembered for his sociological, political, and ethical writings, and not for his biological views (Weinstein, 2002; Harris, 2004). At the time, however, Spencer’s *Principles of biology* (1864–1867) and *Principles of psychology* (1870–1872), both of which contained his definition of life as a particular kind of organism–environment correspondence, were widely read. In 1890, C. S. Peirce and H. F. Osborn debated the merits of Spencer’s biological views in the *New York Times*, and the famous ecologist Frederic Clements apparently ‘expected great things’ of the *Principles of biology* ‘in the days [1890s] when Comtian Spencerian positivism was almost a religion to scientists’ (Osborn, 1890; Peirce, 1890; Pound, 1954, p. 112). The idea of organism–environment interaction is thus an important part of what Sharon Kingsland has called ‘the prehistory of ecology’ (Kingsland, 2004, p. 367), along with the idea of an economy of nature (Pearce, Forthcoming). After all, when Ernst Haeckel coined the word ‘*Oecologie*’, it referred to the science of ‘the relations of the organism to the external world [*Aussenwelt*], the place that each organism takes up in the natural economy [*im Naturhaushalte*]’ (Haeckel, 1866, Vol. 2, p. 287).

In the 1840s, Spencer was exposed to several different accounts of how organisms change in response to changes in their external circumstances. Although Lamarck, Lyell, Humboldt, Crosse, and Chambers disagreed about the details of which conditions affected organisms and to what extent, they all believed that there was a causal relationship between external conditions and organic form. In the terminology of Stephen Jay Gould (1977, pp. 2–6), they were all ‘environmentalist’ rather than ‘internalist’ about ‘the motor of organic change’—even Lamarck, who was primarily internalist, also emphasized the environmentalist ‘force of circumstances’. In the London circle around the publisher John Chapman, these environmentalist views were reaffirmed by thinkers like Newman, Lewes, and Evans, who also introduced him to Comte and the debate over definitions of life. From Comte, who like Spencer is not normally remembered for his biological ideas, the British philosopher inherited the definition of life as a correspondence between organism and *milieu*. This definition then became the centerpiece of Spencer’s system: organism–environment interaction. The physicist John Tyndall summarized Spencer’s account during his inaugural address as president of the British Association for the Advancement of Science:

There are two obvious factors to be here taken into account—the creature and the medium in which it lives, or, as it is often expressed, the organism and its environment. Mr. Spencer’s fundamental principle is that between these two factors there is incessant interaction. (Tyndall, 1874, p. 47)

The term ‘environment’ and Spencer’s abstract organism–environment dichotomy proved extremely portable, and were especially popular with late nineteenth-century American philoso-

phers and psychologists. Tyndall had referred in his lecture to the second edition of Spencer’s *Principles of psychology*, which was published in two volumes in 1870 and 1872. As Spencer (1870, p. vi) wrote in the preface to this work, most people who would read it had likely not read the 1855 edition. This would have been especially true for American readers, as the second edition was the first to be published in the United States. It is this edition that William James assigned to his psychology classes at Harvard, in which he rejected Spencer’s account of organism–environment interaction while retaining the dichotomy (James, 1988, pp. 129–146; 1878; 1880). By the 1890s, the idea of organism–environment interaction had become a standard tool for philosophers like John Dewey. It was standard in science as well: in 1896, Baldwin, Morgan, and Osborn presented a new account of this interaction that suggested a ‘new factor’ in the evolutionary process. The idea even made it into Eliot’s *Middlemarch*, which is framed by the relationship between two different women (Theresa and Dorothea) and their respective environments or media (Eliot, 1874, pp. vii–viii, 620–621; cf. Eliot, 1856).

Many scientists, from Lamarck to Lyell, had discussed the dependence of organisms on particular circumstances; but it was up to Spencer, the philosopher who according to an early phrenological reading had ‘General talent rather than particular genius’, to abstract away from specific conditions to construct the generalized idea of organism–environment interaction (Spencer, 1904, Vol. 1, p. 201). I have tried to show how Spencer’s thinking evolved: he consistently stood on the shoulders of giants like Comte and friends like Lewes. But it was Spencer’s *Principles of psychology* that brought the word ‘environment’ and the idea of organism–environment interaction to much of the world. The idea of environment has a history, and its ubiquity today conceals the work of metaphysical abstraction that produced it.

Acknowledgements

I thank Robert Richards, William Wimsatt, David Jablonski, Denis Walsh, Lynn Nyhart, James Elwick, Elise Berman, participants in the Conceptual and Historical Studies of Science student workshop, and two anonymous referees for reading and commenting on earlier drafts of this paper. Rosemary Ashton of University College London and Ellen Doon of the Beinecke Library at Yale provided me with important information about Lewes’s authorship of various articles in *The Leader*. I also received helpful feedback from audiences at the Smithsonian Museum of Natural History, the 2009 Inland Northwest Philosophy Conference, the Origins: The Historical Sciences in the Age of Darwin conference, and the 2009 meeting of the International Association for Environmental Philosophy.

References

- Amundson, R. (2005). *The changing role of the embryo in evolutionary thought*. Cambridge: Cambridge University Press.
- Ashton, R. (1979). The intellectual ‘medium’ of *Middlemarch*. *Review of English Studies*, 30(May), 154–168.
- Ashton, R. (1991). *G. H. Lewes: A life*. Oxford: Clarendon Press.
- Ashton, R. (2006). *142 Strand: A radical address in Victorian London*. London: Chatto & Windus.
- Baker, W. (1976). Herbert Spencer’s unpublished reminiscences of Thomas Carlyle: The ‘perfect owl of Minerva for knowledge’ on a ‘poet without music’. *Neophilologist*, 60(January), 145–152.
- Beck, N. (2005). Enrico Ferri’s scientific socialism: A Marxist interpretation of Herbert Spencer’s organic analogy. *Journal of the History of Biology*, 38(June), 301–325.
- Blainville, H.-M. D. d. (1833). *Cours de physiologie générale et comparée*, Vol. 3. Paris: Baillière.
- Braunstein, J.-F. (1997). Le concept de milieu, de Lamarck à Comte et aux positivismes. In G. Laurent (Ed.), *Jean-Baptiste Lamarck, 1744–1829* (pp. 557–571). Paris: CTHS.

- Brinton, C. (1933). *English political thought in the nineteenth century*. London: E. Benn.
- Browne, J. (2002). *Charles Darwin: A biography, Vol. 2. The power of place*. Princeton: Princeton University Press.
- Burkhardt, R. W. (1977). *The spirit of system: Lamarck and evolutionary biology*. Cambridge, MA: Harvard University Press.
- Canguilhem, G. (1952). Le vivant et son milieu. In idem, *La connaissance de la vie* (pp. 160–193). Paris: Hachette.
- Canguilhem, G. (1958). La philosophie biologique d'Auguste Comte et son influence en France au XIXe siècle. *Bulletin de la Société française de philosophie*, 52, 13–26.
- Carlyle, T. (1828a). Goethe. *Foreign Review, and Continental Miscellany*, 2(September), 80–127.
- Carlyle, T. (1828b). Goethe's Helena. *Foreign Review, and Continental Miscellany*, 1(January), 429–468.
- Carlyle, T. (1834). Sartor resartus. In three books [Part 2]. *Fraser's Magazine for Town and Country*, 9, 177–195.
- Carneiro, R. L., & Perrin, R. G. (2002). Herbert Spencer's Principles of sociology: A centennial retrospective and appraisal. *Annals of Science*, 59(July), 221–261.
- Carpenter, W. B. (1839–1847). Life. In R. B. Todd (Ed.), *The cyclopaedia of anatomy and physiology, Vol. 3* (pp. 141–160). London: Longman, Brown, Green, Longmans, and Roberts.
- Carpenter, W. B. (1851). *Principles of physiology, general and comparative* (3rd ed.). London: J. Churchill.
- Chambers, R. (1844). *Vestiges of the natural history of creation*. London: J. Churchill.
- Coleridge, S. T. (1848). *Hints towards the formation of a more comprehensive theory of life*. London: J. Churchill.
- Comte, A. (1830). *Cours de philosophie positive, Vol. 1*. Paris: Rouen Frères.
- Comte, A. (1838). *Cours de philosophie positive, Vol. 3*. Paris: Bachelier.
- Comte, A. (1853). *The positive philosophy of Auguste Comte* (2 vols.) (H. Martineau, Trans.). London: J. Chapman.
- Contemporary literature of England. (1852). *Westminster and Foreign Quarterly Review*, 57(January), 247–288.
- Corsi, P. (1988). *The age of Lamarck: Evolutionary theories in France, 1790–1830*. Berkeley: University of California Press.
- Corsi, P. (2001). *Lamarck: Genèse et enjeux du transformisme, 1770–1830*. Paris: Centre national de la recherche scientifique.
- Crispo, E. (2007). The Baldwin effect and genetic assimilation: Revisiting two mechanisms of evolutionary change mediated by phenotypic plasticity. *Evolution*, 61(November), 2469–2479.
- Crosse, J. (1845). The Vestiges, etc. *Westminster Review*, 44(September), 152–203.
- Darwin, C. (1851). Letter to J. D. Hooker, November, 1851. <http://www.darwinproject.ac.uk/darwinletters/calendar/entry-1460.html>. (Accessed 5 April 2010)
- Darwin, C. (1868). *The variation of animals and plants under domestication* (2 vols.). London: J. Murray.
- Darwin, C. (1875). *The variation of animals and plants under domestication* (2nd ed.) (2 vols.). London: J. Murray.
- Desmond, A. (1982). *Archetypes and ancestors: Palaeontology in Victorian London, 1850–1875*. Chicago: University of Chicago Press.
- Development theory and Mr. H. Miller's book. (1850). *The Leader*, 1(4 May), 138.
- Dewey, J. (1896). The reflex arc concept in psychology. *Psychological Review*, 3(July), 357–370.
- Dewey, J. (1898). Evolution and ethics. *Monist*, 8(April), 321–341.
- Dixon, T. (2004). Herbert Spencer and altruism: The sternness and kindness of a Victorian moralist. In G. Jones, & R. A. Peel (Eds.), *Herbert Spencer: The intellectual legacy* (pp. 85–124). London: Galton Institute.
- Dixon, T. (2008). *The invention of altruism: Making moral meaning in Victorian Britain*. Oxford: Oxford University Press.
- Duncan, D. (1908). *The life and letters of Herbert Spencer*. London: Methuen.
- Dyar, H. G. (1896). Stated meeting [9 March]. *Transactions of the New York Academy of Sciences*, 15, 137–143.
- Eisen, S. (1967). Herbert Spencer and the spectre of Comte. *Journal of British Studies*, 7(November), 48–67.
- Eliot, G. (1856). The natural history of German life. *Westminster Review*, 66(July), 51–79.
- Eliot, G. (1874). *Middlemarch: A study of provincial life*. London: W. Blackwood.
- Elliott, P. (2003). Erasmus Darwin, Herbert Spencer, and the origins of the evolutionary worldview in British provincial scientific culture, 1770–1850. *Isis*, 94(March), 1–29.
- Elwick, J. (2003). Herbert Spencer and the disunity of the social organism. *History of Science*, 41(March), 35–71.
- Elwick, J. (2007). *Styles of reasoning in the British life sciences: Shared assumptions, 1820–1858*. London: Pickering & Chatto.
- Emerson, R. W. (1841). *Essays*. London: J. Fraser.
- Erwin, D. H. (2008). Macroevolution of ecosystem engineering, niche construction and diversity. *Trends in Ecology & Evolution*, 23(June), 304–310.
- Francis, M. (1986). Herbert Spencer and the mid-Victorian scientists. *Metascience*, 4, 2–21.
- Francis, M. (2007). *Herbert Spencer and the invention of modern life*. Ithaca, NY: Cornell University Press.
- Godfrey-Smith, P. (1996). *Complexity and the function of mind in nature*. Cambridge: Cambridge University Press.
- Goethe, J. W. von. (1814). *Aus meinem Leben, Dichtung und Wahrheit, Vol. 1 [Pt. 3]*. Tübingen: J. G. Cotta.
- Gondermann, T. (2007). Progression and retrogression: Herbert Spencer's explanations of social inequality. *History of the Human Sciences*, 20(August), 21–40.
- Gordon, S. (1955). The London *Economist* and the high tide of laissez faire. *Journal of Political Economy*, 63(December), 461–488.
- Gould, S. J. (1977). Eternal metaphors of palaeontology. In A. Hallam (Ed.), *Patterns of evolution as illustrated by the fossil record* (pp. 1–26). Amsterdam: Elsevier.
- Gould, S. J. (2002). *The structure of evolutionary theory*. Cambridge, MA: Harvard University Press.
- Greene, J. C. (1959). Biology and social theory in the nineteenth century: Auguste Comte and Herbert Spencer. In M. Clagett (Ed.), *Critical problems in the history of science* (pp. 419–446). Madison, WI: University of Wisconsin Press.
- Haeckel, E. (1866). *Generelle Morphologie der Organismen* (2 vols.). Berlin: G. Reimer.
- Haight, G. S. (Ed.). (1954–1978). *The George Eliot letters* (9 vols.). New Haven, CT: Yale University Press.
- Haight, G. S. (1976). The Carlyles and the Leweses. In J. Clubbe (Ed.), *Carlyle and his contemporaries: Essays in honor of Charles Richard Sanders* (pp. 181–204). Durham, NC: Duke University Press.
- Harris, J. (2004). Spencer, Herbert (1820–1903). In *Oxford dictionary of national biography*. Oxford: Oxford University Press. <http://www.oxforddnb.com/view/article/36208>. (Accessed 5 April 2010)
- Herbert Spencer dead. (1903). *New York Times*, 9 December, 8.
- Hofstadter, R. (1944). *Social Darwinism in American thought, 1860–1915*. Philadelphia: University of Pennsylvania Press.
- Huxley, T. H. (1854). Science. *Westminster Review*, 61(January), 254–270.
- James, W. (1878). Remarks on Spencer's definition of mind as correspondence. *Journal of Speculative Philosophy*, 12(January), 1–18.
- James, W. (1880). Great men, great thoughts, and the environment. *Atlantic Monthly*, 46(October), 441–459.
- James, W. (1988). *Manuscript lectures*. Cambridge, MA: Harvard University Press.
- Jones, G., & Peel, R. A. (Eds.). (2004). *Herbert Spencer: The intellectual legacy*. London: Galton Institute.
- Jones, R. A. (1970). Comte and Spencer: A priority dispute in social science. *Journal of the History of the Behavioral Sciences*, 6(July), 241–254.
- Jones, T. R. (1841). *A general outline of the animal kingdom, and manual of comparative anatomy*. London: J. van Voorst.
- Kingsland, S. E. (2004). Conveying the intellectual challenge of ecology: An historical perspective. *Frontiers in Ecology and the Environment*, 2(September), 367–374.
- Kittredge, H. E. (1903). Appreciation of Spencer. *Washington Post*, 14 December, 9.
- La Vergata, A. (1995). Herbert Spencer: Biology, sociology, and cosmic evolution. In S. Maasen, E. Mendelsohn, & P. Weingart (Eds.), *Biology as society, society as biology: Metaphors* (pp. 193–230). Dordrecht: Kluwer.
- Lamarck, J.-B. (1801). Discours d'ouverture prononcé le 21 floréal An 8 [1800]. In idem, *Système des animaux sans vertèbres, ou Tableau général des classes, des ordres et des genres de ces animaux* (pp. 1–48). Paris: Deterville.
- Lamarck, J.-B. (1809). *Philosophie zoologique, ou Exposition des considérations relatives à l'histoire naturelle des animaux* (2 vols.). Paris: Dentu.
- Lewes, G. H. (1845–1846). *A biographical history of philosophy* (4 vols.). London: C. Knight.
- Lewes, G. H. (1850). Philosophy at Cambridge. *The Leader*, 1(7 September), 566–567.
- Lewes, G. H. (1851a). Lyell and Owen on development. *The Leader*, 2(18 October), 996–997.
- Lewes, G. H. (1851b). Spencer's 'Social statics'. *The Leader*, 2, 248–250, 274–275, 347–348.
- Lewes, G. H. (1852a). Comte's *Positive philosophy*, Pt. XIV. The science of life. *The Leader*, 3(10 July), 665–666.
- Lewes, G. H. (1852b). Comte's *Positive philosophy*, Pt. XV. Scope and method of biology. *The Leader*, 3(17 July), 688–689.
- Lewes, G. H. (1852c). Goethe as a man of science. *Westminster Review*, 58(October), 258–272.
- Lewes, G. H. (1853a). *Comte's philosophy of the sciences: Being an exposition of the principles of the Cours de philosophie positive of Auguste Comte*. London: H. G. Bohn.
- Lewes, G. H. (1853b). The development hypothesis of the 'Vestiges'. *The Leader*, 4, 784–785, 812–814, 832–834.
- Lewes, G. H. (1853c). Von Baer on the development hypothesis. *The Leader*, 4(25 June), 617–618.
- Lewontin, R. C. (1983). Gene, organism and environment. In D. S. Bendall (Ed.), *Evolution from molecules to men* (pp. 273–285). Cambridge: Cambridge University Press.
- Limoges, C. (1994). Milne–Edwards, Darwin, Durkheim and the division of labour: A case study in reciprocal conceptual exchanges between the social and the natural sciences. In I. B. Cohen (Ed.), *The natural and the social sciences: Some critical and historical perspectives* (pp. 317–343). Dordrecht: Kluwer.
- Literature. (1849). *The Economist*, 7(17 February), 183–184.
- Literature. (1853). *The Economist*, 11(10 December), 1386–1388.
- Lucy, J. A. (1992a). *Grammatical categories and cognition: A case study of the linguistic relativity hypothesis*. Cambridge: Cambridge University Press.
- Lucy, J. A. (1992b). *Language diversity and thought: A reformulation of the linguistic relativity hypothesis*. Cambridge: Cambridge University Press.
- Lyell, C. (1832). *Principles of geology, being an attempt to explain the former changes of the Earth's surface, by reference to causes now in operation, Vol. 2*. London: J. Murray.
- Lyell, C. (1851). Anniversary address of the President. *Quarterly Journal of the Geological Society*, 7, xxv–lxxxv.
- Martineau, H., & Atkinson, H. G. (1851). *Letters on the laws of man's nature and development*. London: J. Chapman.

- Milne-Edwards, H. (1851). *Introduction à la zoologie générale, ou Considérations sur les tendances de la nature dans la constitution du règne animal*. Paris: V. Masson.
- Miscellaneous notices: Philosophy and science. (1844). *Westminster Review*, 42(December), 528.
- Miscellaneous notices: Philosophy and science. (1845a). *Westminster Review*, 43(March), 255.
- Miscellaneous notices: Philosophy and science. (1845b). *Westminster Review*, 43(June), 483.
- Newman, F. W. (1845). *Vestiges of the natural history of creation*. *Prospective Review*, 1(January), 49–82.
- Newman, F. W. (1849). *The soul, her sorrows and her aspirations: An essay towards the natural history of the soul, as the true basis of theology*. London: J. Chapman.
- Newman, F. W. (1850). *Phases of faith; Or, passages from the history of my creed*. London: J. Chapman.
- Osborn, H. F. (1890). The Spencerian biology. *New York Times*, 6 April, 13.
- Owen, R. (1848). *On the archetype and homologies of the vertebrate skeleton*. London: J. van Voorst.
- Owen, R. (1849a). Hunterian lectures on the generation and development of the invertebrated animals: Lecture VII. *Medical Times*, 19(23 June), 615–617.
- Owen, R. (1849b). *On parthenogenesis, or the successive production of procreating individuals from a single ovum*. London: J. van Voorst.
- Owen, R. (1851a). Lyell: On life and its successive development. *Quarterly Review*, 89(September), 412–451.
- Owen, R. (1851b). Synopsis of the Hunterian lectures on comparative osteology. *Edinburgh New Philosophical Journal*, 50(April), 329–334.
- Oyama, S., Griffiths, P. E., & Gray, R. D. (Eds.). (2001). *Cycles of contingency: developmental systems and evolution*. Cambridge, MA: MIT Press.
- Pearce, T. (Forthcoming). 'A great complication of circumstances': Darwin and the economy of nature. *Journal of the History of Biology*.
- Peel, J. D. Y. (1971). *Herbert Spencer: The evolution of a sociologist*. London: Heinemann.
- Peel, J. D. Y. (2004). Spencer in history: The second century. In G. Jones, & R. A. Peel (Eds.), *Herbert Spencer: The intellectual legacy* (pp. 125–149). London: Galton Institute.
- Peirce, C. S. (1890). A Fairfield and no favor. *New York Times*, 13 April, 13.
- Perrin, R. G. (1993). *Herbert Spencer: A primary and secondary bibliography*. New York: Garland.
- Petit, A. (1997). L'héritage de Lamarck dans la philosophie positive d'Auguste Comte. In G. Laurent (Ed.), *Jean-Baptiste Lamarck, 1744–1829* (pp. 543–556). Paris: CTHS.
- Postlethwaite, D. (1984). *Making it whole: A Victorian circle and the shape of their world*. Columbus, OH: Ohio State University Press.
- Pound, R. (1954). Frederic E. Clements as I knew him. *Ecology*, 35(April), 112–113.
- Renwick, C. (2009). The practice of Spencerian science: Patrick Geddes's biosocial program, 1876–1889. *Isis*, 100(March), 36–57.
- Richards, E. (1987). A question of property rights: Richard Owen's evolutionism reassessed. *British Journal for the History of Science*, 20(April), 129–171.
- Richards, R. J. (1987). *Darwin and the emergence of evolutionary theories of mind and behavior*. Chicago: University of Chicago Press.
- Richards, R. J. (1992). *The meaning of evolution: The morphological construction and ideological reconstruction of Darwin's theory*. Chicago: University of Chicago Press.
- Rupke, N. (1985). Richard Owen's Hunterian lectures on comparative anatomy and physiology, 1837–55. *Medical History*, 29(July), 237–252.
- Rylance, R. (2000). *Victorian psychology and British culture, 1850–1880*. Oxford: Oxford University Press.
- Schiller, F. C. S. (1911). Spencer, Herbert. In *The encyclopaedia Britannica: A dictionary of arts, sciences, literature and general information*, Vol. 25 (pp. 634–637). New York: Encyclopaedia Britannica.
- Secord, J. A. (2000). *Victorian sensation: The extraordinary publication, reception, and secret authorship of 'Vestiges of the natural history of creation'*. Chicago: University of Chicago Press.
- Sedgwick, A. (1850). *A discourse on studies of the University of Cambridge* (5th ed.). London: J. W. Parker.
- Sharlin, H. I. (1976). Herbert Spencer and scientism. *Annals of Science*, 33(September), 457–480.
- Sloan, P. R. (2005). Evolution. In E. N. Zalta (Ed.), *Stanford encyclopedia of philosophy* (Summer 2005 ed.). Stanford: Metaphysics Research Lab, CSLI, Stanford University. <http://plato.stanford.edu/archives/sum2005/entries/evolution/>. (Accessed 5 June 2009)
- Sloan, P. R. (2008). Evolution. In E. N. Zalta (Ed.), *Stanford encyclopedia of philosophy* (Fall 2008 ed.). Stanford: Metaphysics Research Lab, CSLI, Stanford University. <http://plato.stanford.edu/archives/fall2008/entries/evolution/>. (Accessed 5 June 2009)
- Smith, C. U. M. (1982). Evolution and the problem of mind. Pt. I. Herbert Spencer. *Journal of the History of Biology*, 15(March), 55–88.
- Smith, S. (1838). *The principles of phrenology*. Edinburgh: W. Tait.
- Spencer, H. (1842a). The proper sphere of government, Letter I. *The Nonconformist*, 2(15 June), 410–411.
- Spencer, H. (1842b). The proper sphere of government, Letter IX. *The Nonconformist*, 2(23 November), 779–780.
- Spencer, H. (1851). *Social statics: Or, the conditions essential to human happiness specified, and the first of them developed*. London: J. Chapman.
- Spencer, H. (1852a). A theory of population, deduced from the general law of animal fertility. *Westminster and Foreign Quarterly Review*, 57(April), 468–501.
- Spencer, H. (1852b). The development hypothesis. *The Leader*, 3(March 20), 280–281.
- Spencer, H. (1852c). The philosophy of style. *Westminster Review*, 58(October), 234–247.
- Spencer, H. (1854). The genesis of science. *British Quarterly Review*, 20(July), 108–162.
- Spencer, H. (1855). *The principles of psychology*. London: Longman, Brown, Green, and Longmans. (Available at <http://oll.libertyfund.org/>)
- Spencer, H. (1862). *First principles*. London: Williams and Norgate.
- Spencer, H. (1864–1867). *The principles of biology* (2 vols.). London: Williams and Norgate.
- Spencer, H. (1870). *The principles of psychology, Vol. 1* (2nd ed.). London: Williams and Norgate.
- Spencer, H. (1893). The inadequacy of 'natural selection'. *Contemporary Review*, 63(February/March), 153–166, 439–456.
- Spencer, H. (1899). The filiation of ideas. In D. Duncan (Ed.), *The life and letters of Herbert Spencer* (pp. 533–576). London: Methuen.
- Spencer, H. (1904). *An autobiography* (2 vols.). London: Williams and Norgate.
- Strauss, D. F. (1846). *The life of Jesus critically examined* (M. Evans, Trans.). London: J. Chapman.
- Taylor, M. W. (2007). *The philosophy of Herbert Spencer*. London: Continuum.
- Thompson, D. A. W. (1913). *On Aristotle as a biologist, with a prooemion on Herbert Spencer*. Oxford: Clarendon Press.
- Tyndall, J. (1874). *Address delivered before the British Association assembled at Belfast, with additions*. London: Longmans, Green, and Co.
- Versen, C. (2006). *Optimistic liberals: Herbert Spencer, the Brooklyn Ethical Association, and the integration of moral philosophy and evolution in the Victorian trans-Atlantic community*. Ph.D. thesis, Florida State University.
- Walsh, J. J. (1900). A half-century in biology. *Catholic World*, 70(January), 466–479.
- Weinstein, D. (2002). Herbert Spencer. In E. N. Zalta (Ed.), *Stanford encyclopedia of philosophy* (Winter 2002 ed.). Stanford: Metaphysics Research Lab, CSLI, Stanford University. <http://plato.stanford.edu/archives/win2002/entries/spencer/>.
- Weismann, A. (1893). The all-sufficiency of natural selection. *Contemporary Review*, 64(September/October), 309–338, 596–610.
- Werth, B. (2009). *Banquet at Delmonico's*. New York: Random House.
- White, P. (2002). Cross-cultural encounters: The co-production of science and literature in mid-Victorian periodicals. In R. Luckhurst, & J. McDonagh (Eds.), *Transactions and encounters: Science and culture in the nineteenth century* (pp. 75–95). Manchester: Manchester University Press.
- Wilson, J. (1839). *Influences of the Corn Laws, as affecting all classes of the community, and particularly the landed interests*. London: Longman, Orme, Brown, Green, and Longmans.
- Wright, T. R. (1886). *The religion of humanity: The impact of Comtean positivism on Victorian Britain*. Cambridge: Cambridge University Press.
- Young, R. M. (1970). *Mind, brain and adaptation in the nineteenth century*. Oxford: Oxford University Press.