Pergamon

Stud. Hist. Phil. Biol. & Biomed. Sci., Vol. 29, No. 2, pp. 349–357, 1998

Printed in Great Britain
1369–8486/98 $19.00+0.00

Essay Review

The *Origin* Unbound

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David Amigoni and Jeff Wallace (eds), *Charles Darwin's The Origin of Species. New Interdisciplinary Essays*, Texts in Culture series (Manchester: Manchester University Press, 1995), xii + 211 pp., ISBN 0-7190-4025-6 Paperback £13.99.

David J. Depew and Bruce H. Weber, *Darwinism Evolving. Systems Dynamics and the Genealogy of Natural Selection* (London: Bradford Books/MIT Press, 1995), xiii + 588 pp., ISBN 0-262-04145-6 Hardback £40.00, Paperback £19.50.

Well before 1859, the veterinary surgeon William Youatt was hailing selection as 'the magician's wand, by means of which he may summon into life whatever form and mould he pleases'. Youatt had in mind the power of the breeder in the barnyard, but his words, quoted in the *Origin of Species*, equally capture the spirit of Darwin's performance on the page, the sense the reader has of an effortless conjuring of form after form by appeal to selection. At one point Darwin confronts the perfection of the honeycomb. The hexagonal geometries of its cells store the greatest possible amount of honey per unit of wax, yet this most efficient design, beyond the skills of even the master craftsman, is the work of an uncoordinated swarm of bees. His stage set, his audience dubious, the magician proceeds. He notes first that a graduated series of structures exists at present, from the humble-bee's irregular round cells through the Melipona bee's comb of regular cylindrical cells to the hive-bee's comb of regular hexagonal cells. Next he presents a geometrical argument and a number of experimental results to suggest that 'if we could slightly modify the instincts already possessed by the Melipona, and in themselves not very wonderful, this bee would make a structure as wonderfully perfect as that of the

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PII: S1369-8486(98)00021-1

hive-bee'. The concluding *voilà* is that any variation in the direction of greater economy which chanced to arise among the Melipona-like bees of the past would have been preserved by selection, given that honey is so precious over the winter months, and that so much of it must be consumed to make even a small quantity of wax.[1]

Observing this pass of the wand, what would the reader gain by a keener sense of context? Broadly speaking, there are two approaches to contextualization. In his classic *On Growth and Form*, D'Arcy Thompson placed the Darwinian account of the honeycomb within a tradition of mathematical and natural historical inquiry to which Pappus, Kepler, Maraldi, Fontenelle, MacLaurin, and Buffon contributed, among many others. According to Thompson, the analysis on which Darwin depended came out of an eighteenth century so charmed by the notion of maximization in nature that it turned a blind eye to the imperfect dimensions of real honeycombs. (Specifically, Thompson blamed Henry Lord Brougham for transmitting the error to Darwin, in Brougham's popular *Dissertation on Subjects of Science*.) In fact, said Thompson, the 'bee makes no economies' at all. He sided with Buffon: the hexagonal configuration of the cells derives from the tensile properties of wax under the conditions of the hive, not from any adaptive sculpting power wielded by the bees.[2]

Context of Thompson's sort is like a gallery of masterpieces, in the midst of which the reader can better appreciate the nature and origin of certain elements of the Darwinian style. The other approach to context trades the gallery for the workshop. Restored to the material and ideological hurlyburly in which it was crafted, Darwin's explanation of the honeycomb appears shot through with politics. Its naturalism was a challenge and an insult to those (such as Brougham) for whom divine beneficence *was* a scientific explanation, and evolution a dangerous absurdity. The experiments Darwin described signalled membership in a gentlemanly group which had leisure enough to ponder, potter, and correspond voluminously. The questions which motivated the inquiry, and the 'one long argument' in which it appeared, arose for Darwin on a globe-circling voyage carried out for the sake of empire. The workshop world presses on the *Origin* no less than the gallery world. The challenge to commentary is to give both worlds their due while throwing light on the work itself (which is not the sum of its contexts). Two recent books attempt to meet this challenge.

The collection edited by David Amigoni and Jeff Wallace offers itself primarily to students of literature as an interdisciplinary guide to the *Origin* and its times. The strongest essays assess the *Origin* as a political resource. In India, as Dermot Killingley shows, the reception of Darwinism among Hindu intellectuals was a comparatively smooth affair. Many had studied mathematics, the physical sciences, natural history, and geography with missionaries who hoped an acquaintance with

[1]C. Darwin, *On the Origin of Species by Means of Natural Selection* (London: John Murray, 1859), pp. 31, 224–235, quotation on p. 227.

[2]D. W. Thompson, *On Growth and Form*, 2nd edition (Cambridge: Cambridge University Press, 1944), pp. 525–544, quotation on p. 538.

Western science would flush out their pupils' religion (thus making room for the true religion). The strong British presence and, from 1857, modern universities in Calcutta, Bombay, and Madras ensured rapid dissemination among the Indian intelligentsia of the latest scientific books and ideas. But a more relaxed attitude to doctrine, to the authority of sacred texts in matters of cosmology meant, in Dr Killingley's words, that it 'was easier for a Hindu to combine modern knowledge with adherence to tradition than for a Muslim, or even, as might appear from the controversies in the West over Darwin, for a Christian' (p. 179). Unlike Christians, Hindus viewed creation as a process, an unfolding act of differentiation. Their cosmos was ageless, their kinship with animals and plants a matter of course. Controversy erupted over what Darwinism—in India, as elsewhere, a synonym for 'evolution' generally—implied for the nation and its future. Liberals campaigned for harmony with nature's law of progress through the release of society from the restraints of tradition and superstition. (The social reformer Ashkay Kumar Datta kept a portrait of Darwin alongside one of Newton in his house outside Calcutta in the 1880s.) Against the liberals, nationalists insisted that Western science was only catching up with the Veda, which taught of telegraphs and steamships as well as evolution, and which held out the promise of spiritual progress alongside material progress.

On the *Origin*'s home territory, what Fiona Erskine calls a 'science of female inferiority' emerged from and reinforced a robust consensus that unequal relations between the sexes were the product of evolution. Herbert Spencer, for example, linked degree of difference between the sexes in a particular society with its state of civilization. Spencer deplored feminist attempts to elide the distinctions nature was honing to perfection. From a more Darwinian perspective, emphasizing selection on variation over universal imperatives, Darwin's protégé G. J. Romanes came to much the same verdict (like his master before him). What surprises about naturalized inequality in post-Darwinian Britain and America, however, is that it could be used by as well as against feminists, as Eliza Burt Gamble and Charlotte Perkins Gilman evidenced. Gamble celebrated sexual selection as the guarantor of progress, and feminism as the guarantor of sexual selection. In *The Evolution of Woman* (1894), she argued that, in Dr Erskine's summary, the 'overruling of female choice through the economic dominance of the male, meant that the unfit male was no longer eliminated by sexual selection and the course of evolution was perverted' (p. 113). Give women more power to select men by giving them more power as such, and progress would follow. To Gilman, however, the problem was not too little sexual selection, but too much. Her *Women and Economics* (1898) depicted a world where the regulation of female choice by the exigencies of survival, the curbing of sexual by natural selection, had ceased, giving rise to runaway divergence and degeneracy. Mate choice by cosseted women who had nothing to do but choose mates was ruining both sexes. Women with real power and responsibilities would select more sensibly and so set evolution back on track.

These essays dwell in the fine texture of transactions between the *Origin* and its contexts. Other topics are treated, less successfully, with a broader brush. Kate

Flint sets the *Origin* beside *Great Expectations*, published the following year, 'to show that Dickens shared a common set of concerns, and to some extent a common language' (p. 153) with Darwin and other men of science. As for language, the analysis leans heavily on comparisons in Dickens between human and animal behavior ('"What is detestable in a pig, is more detestable in a boy"', 'with his mouth snarling like a tiger's' etc.). Such comparisons are the timeless stock-in-trade of the storyteller; but perhaps they really did acquire new poignancy for authors and readers alike around 1860. More troublesome is the claim for common concerns. When Estella speaks of 'my nature... the nature formed within me', Dr Flint bids us read a nurture-over-nature thesis, and comments that 'Dickens, on this point, seems closer to Lamarck's ameliorative theories than to Darwin' (p. 168). Whether or not blood routs circumstance in *Great Expectations*—others have read a more hereditarian thesis, if anything[3]—Darwin states nothing whatsoever in the *Origin* about character and its formation. Did the views expressed there somehow imply or entail that blood is destiny? 'Important as the struggle for existence has been and even still is', Darwin wrote in *The Descent of Man* (1871), in which he addressed himself explicitly to human matters, 'yet as far as the highest part of man's nature is concerned there are other agencies more important. For the moral qualities are advanced, either directly or indirectly, much more through the effects of habit, the reasoning powers, instruction, religion, etc. than through natural selection'.[4] The 1859 *Origin* is no less generous in its assessment of 'the effects of habit' associated with Lamarck.

Great Expectations is a fictional inquiry into the origins of character; the *Origin of Species* is a scientific inquiry into the origins of adaptation (hence species). Both were published at roughly the same time. Their authors were elected to the Athenaeum on the same day (21 June 1838). *Great Expectations* was serialized in the journal Dickens edited, not long after the same journal had run two articles on the *Origin of Species*. Do these coincidences and contiguities justify a claim for dialogue, however indirect, however culturally mediated, between Darwin and Dickens, no matter their overt differences in mode and purpose? Do we see their works more clearly by situating them in a unitary context? Another contributor, Ted Benton, sounds a salutary note of caution. 'Analytical procedures which seek to assimilate Darwin's *Origin* to the "common culture" also tend, if they remain unqualified, to efface the significance of the profound conceptual innovation achieved in the former' (p. 77). If Darwin's text darkens under a broad brush, so too does Dickens', which ceases in this analysis to be a novel at all, only a mausoleum of opinions and arguments, expressed in code.

Separately, the other essays in this set inform on a number of points, from metaphor and taxonomy (Harriet Ritvo) to Darwin's use of Malthus (Professor Benton) to the *Origin* as literary artifact and influence (Dr Wallace and Dr Amigoni,

[3]See Richard Lewontin's 'In the Blood', *The New York Review of Books*, 23 May 1996, pp. 32–33.

[4]C. Darwin, *The Descent of Man, and Selection in Relation to Sex*, vol. II, (London: John Murray, 1871), pp. 403–404.

respectively). But the whole remains a mosaic of miniatures, uneven in quality and uncoordinated in theme. Altogether more satisfying is David Depew and Bruce Weber's *Darwinism Evolving*. Here is a history of evolutionary theory of rare scope and analytic brio, alive to the gallery and the workshop no less than to the works themselves. It argues that natural selection depends for its elaboration on dynamical models from the physical sciences. As these models of change in physical systems have themselves changed, so has the theory of natural selection. The first part of the book examines the role of Newtonian models in the *Origin*. The second part tracks the fortunes of Darwinism through its eclipse and re-emergence, as a 'Boltzmannian' theory, in the modern synthesis of the 1930s and '40s. The third and final part introduces the new models which, once assimilated, will, the authors predict, carry Darwinism through current crises into the future.

Is the *Origin* an appendix to the *Principia*? The claim recalls Darwin's famous conclusion, that 'whilst this planet has gone cycling on according to the fixed law of gravity, from so simple a beginning endless forms most beautiful and most wonderful have been, and are being, evolved'.[5] But there is much more. The creatures Darwin presents belong to life-cycle trajectories of growth and reproduction that project through time and space unless deflected by external forces. These forces are principally two. The first is sex, which maintains the coherence of a kind by blending the varying traits of parent organisms. (On this point as on others, Darwin parted company with contemporaries such as Cuvier and von Baer: coherence had to be actively maintained in the face of wave after wave of variation.) The second force is natural selection, which, in a changing world, where too many organisms struggle for too few resources, splits one kind into many divergent and better adapted kinds. With species as with planets, the pathways result from equilibrium between inertial movement and impinging forces. Consider the eighteenth-century sense of dynamic equilibrium, of opposing agencies in a constantly-adjusting balance, in the following passage, from the second chapter on geographical distribution (not discussed by the authors):

> …species occasionally arriving after long intervals in a new and isolated district, and having to compete with new associates, will be eminently liable to modification, and will often produce groups of modified descendants… [but] Bermuda and Madeira have been stocked by birds, which for long ages have struggled together in their former homes, and have become mutually adapted to each other; and when settled in their new homes, each kind will have been kept by the others to their proper place and habits, and will consequently have been little liable to modification. Any tendency to modification will, also, have been checked by intercrossing with the unmodified immigrants from the mother country.[6]

The authors contend that the Newtonian style of Darwin's science was as much a legacy of his background as were his life of leisure and his views on slavery. They argue that Dissenting Whigs such as Darwin, Charles Lyell, and John Her-

[5]Darwin, *Origin*, *op. cit.*, p. 490.

[6]Darwin, *Origin*, *op. cit.*, pp. 390–391. The last sentence appears from the second edition. See the World's Classics *Origin*, edited by Gillian Beer (Oxford: Oxford University Press, 1996), p. 316.

schel were the center that held in English society through the often turbulent first half of the nineteenth century. (Herschel was their methodologist laureate, his own views characteristically midway between those of the Oxbridge Tory William Whewell and the liberal–radical John Stuart Mill.) The divine legislation which governed Newton's universe had underwritten the great compromise of 1688 between religious and antireligious fanaticism, a writ for moderation to which the Dissenting Whigs were heirs and guardians. Laws derived from or modelled on the laws of motion and gravity had spread throughout the physical and the moral sciences in the eighteenth century, revealing the self-regulating machine within system after system. But mechanical explanation was not to extend to life itself. Life was where the prevision and provision of the Lord, His beneficence and concern, shone forth, and only teleological explanations were permissible. In the nineteenth century the strains began to mount: with the transmutationist challenges of Lamarck, Geoffroy, Grant, and Chambers; with the natural theological extremes of the Tory *Bridgewater Treatises*; with the scarcely governed tension, in Lyell's uniformitarian *Principles of Geology*, within 'Newtonian environments filled with Aristotelian organisms' (p. 107); with Herschel's insistence, in his treatise on methodology, that purpose had no explanatory role, that all explanations in science had to be built, like Newton's, on 'true causes', present to the senses. What Darwin took from political economy were the models he needed to resolve this crisis.

His models appealed to an increasingly—D'Arcy Thompson might have added 'mischievously'—common feature of the dynamical landscape: the 'principle of least action', according to which certain quantities in a changing system are brought to a maximum or a minimum. By way of the Belgian physiologist Henri Milne-Edwards's concept of the 'physiological division of labour'—the debt to Adam Smith's Newtonian economics was acknowledged—Darwin completed a theory of life that tied together a number of least-action principles. From Malthus he took his foundation, that offspring tended to a maximum. This 'superfecundity' entailed a competition among individuals for resources like that which obtained in a free-market economy. On Smith's analysis, such a system would generate an ever more complete division of labor and thus an ever more efficient allocation of resources and an ever expanding economy. Milne-Edwards' claim, that the scale of organization in living forms revealed an ever increasing division of labor among their parts, completed the bridge between nature and capitalism. Whether in the market place or in nature, competition generated a maximal number of maximally diverse and specialized competitors. Together, the art of the fanciers and the arguments of the political economists served to bring life into the Newtonian–Herschelian realm of true causes and uniform laws. What variously thrilled, unnerved, and outraged about Darwin's explanation was that it 'very nearly succeeded in extending his culture's most respected scientific model to objects and processes from which it was supposed to keep its distance' (p. 10).

Models mediate between the drive to explain the world and the world itself. Imported from other contexts, they are custom-fitted to explain new phenomena, opening a vast space for disagreement over whether the new model shares in the

virtues which made the old model attractive. (All the Victorian methodologists held natural selection in low regard, even Herschel, who derided it as 'the law of higgledy-piggledy'. What was Newtonian about a process that applied across heterogeneous chance events?) Furthermore, all models as such draw out certain features of the world while suppressing others. Any judgement about the legitimacy of a model and its extension or application brings into play a range of commitments, and it is these—methodological, empirical, metaphysical, institutional—which root the judgement to its matrix.[7] By putting models at the center, Professors Depew and Weber have harvested the insights of social historians of science without collapsing theory into sociology or political struggle. Their emphasis on Darwin's Whig background leads not to a triumphant unmasking of natural selection as a capitalist ploy, but rather to a view of how that background bred in Darwin commitments which rendered the models of Smith and Malthus, ready-to-hand as they were, suitable for new uses. We trade a gentlemanly agent of the rising bourgeoisie for a creative thinker who was nevertheless of his time and place.

A second reason models matter in this account is that they decouple natural selection from the prism of dynamics. Although discovered with Newtonian models of system change, the phenomenon of selection is independent of any one family of dynamical models, and the great historical arc the authors trace is the passage of selection from one family (with all its closeted skeletons) to another. They judge R. A. Fisher's *The Genetical Theory of Natural Selection* (1930) to be the most important work in evolutionary theory after the *Origin*. Here three currents in the floodtide of the probability revolution met with great force: the physics of Maxwell and Boltzmann (whose models Fisher learned to think through as a post-doctoral student under James Jeans at Cambridge); the statistical selection studies of Galton, Pearson, and Weldon (together with the dreams of a 'eugenic life' which drove them); and the population genetics which Fisher, Haldane, Wright and others had been slowly assembling. The entities in genetic Darwinism were not organisms-in-transit but vast arrays of genes. Like molecules in a gas, these were presumed to act independently of one another, and to create potential gradients whose erosion and exhaustion wrought predictable change in the system as a whole. What was maximized in each system, however, was quite different, as Fisher explained:

> It will be noticed that [my] fundamental theorem… bears some remarkable resemblances to the second law of thermodynamics. Both are properties of populations, or aggregates, true irrespective of the nature of the units which compose them; both are statistical laws; each requires the constant increase of a measurable quantity, in the one case the entropy of a physical system and in the other the fitness…entropy changes lead to a progressive disorganization of the physical world, at least from the human standpoint of the utilization of energy, while evolutionary changes are

[7] *Darwinism Evolving* takes its view of models and science from Ronald Giere's *Explaining Science: A Cognitive Approach* (Chicago: University of Chicago, 1988).

> generally recognized as producing progressively higher organization in the organic world.[8]

Upturned, the sloping valley of thermodynamic diagrams became the adaptive peak of genetic Darwinism, the first in a series of transformations on the path to the modern synthesis. The ascent of atomistic genes up 'Mount Fitness' (Richard Lewontin's sarcastic phrase) gave way almost immediately to genetic bundles blown by chance and selection across the adaptive landscapes of Sewall Wright. Collecting data on gene frequencies in fruit-fly populations, Theodosius Dobzhansky mapped this abstraction onto the real ecologies he traversed in the California mountains. In Dobzhansky's hands, 'Wright's inadaptive valleys, or at least the most barren of them, come to be identified, willy-nilly, with the actual barriers—geographic, ecological, and physiological—that divide species, as well as their component populations, into discrete units' (p. 308). With Ernst Mayr, any residual genotypic concepts disappeared into flesh-and-blood phenotypes: migrating founders replaced gene flows; spatially-distributed populations replaced genetic arrays. '[M]ore like a treaty than a theory' (p. 300), the synthesis that Dobzhansky, Mayr, Julian Huxley, and G. G. Simpson ratified in the 1940s decreed an evolutionary biology with speciation at its core. Developmental processes at all scales were cast out, along with the scientists who studied them.

According to the authors, the treaty has begun to unravel with the revolution in molecular biology. They survey a number of recent debates: over the role of selection in apparently clocklike molecular evolution; over the adaptationist 'selfish gene' perspective; over the expansion of selection to entities above as well as below the level of the organism. Above all, they lay stress on research which, since Jacob and Monod, has revealed the complexity of arrangements whereby genes regulate the expression of other genes and the fluidity of those arrangements. New dynamical models developed by Stuart Kauffman and others suggest that, within certain boundary conditions, generic 'order for free' crystallizes out of systems which (like genomes, the prebiotic oceans, ecosystems) feature vast arrays of interconnected entities. With no single chain of command, but simply in virtue of size and connectivity—these are the parameters which must be suitably tuned, by the modeller at the computer and by selection in nature—these systems show self-organization despite total randomness at the level of individual connections. The final chapters of *Darwinism Evolving* are a plea for a rejuvenated Darwinism wed to models like Kauffman's, which presume complexity rather than abstracting it away, which trade *post facto* narratives for predictive power, which take adaptability as the supreme adaptation, and which return to the evolutionary fold hitherto excluded aspects of life such as its origin, its grand patterns and rhythms, and the mechanics of individual development and ecological energetics.

No summary can convey the exuberance and reach of this book. Crowding the narrative of change in evolutionary theory are brief but thorough histories of bio-

[8]R. A. Fisher, *The Genetical Theory of Natural Selection*, 2nd edition (New York: Dover, 1958), pp. 39–40, cited by Depew and Weber, p. 253.

chemistry, ecology, embryology, cytology, physics, statistics, sociology, vitalism, genetics, eugenics, social Darwinism, progressive Darwinism, and American, British, German, French, and Russian evolutionary thought, among many other topics. (Comprehensive reading guides follow each of the three parts.) Equally impressive is the way the authors weave together the scientific, the personal, and the world-historical, and the sophistication of their treatment of philosophical issues. More difficult to assess is the service they render to the *Origin*. Unquestionably they return the reader to Darwin's text with wider sympathies. But what of the new Darwinism they champion? Deliberately, nothing like bees or honeycombs appears in their sketch of the new evolutionary theory. The authors regard the focus on peculiar forms and behaviors, characteristic of Dawkins' science no less than Darwin's, as a barrier to understanding, a vestige from natural theology which has overstayed its welcome. Whether the re-orientation they demand would preserve anything of Darwinism but the name is far from clear. They observe at one point that the Newtonian tradition in physics 'amended its original conceptual and ontological structure out of existence' (p. 92). This history, an uncommonly generous act of homage to the Darwinian tradition, presents the reader nevertheless with a glimpse of its extinction. Is the curtain falling at last on the old magician?

Unbound is a side quest that requires the Warden to find some missing notes in order to uncover an ancient mystery. In order to obtain this quest you need to do three things (in no particular order): Get the letter off the dead adventurer's corpse located down the first hallway on the left after entering the Ruined Temple accessible during or after The Urn of Sacred Ashes quest.