

RECENT DEVELOPMENTS IN THE HISTORY OF EVOLUTION THEORY

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For English-speaking historians of science, the so-called 'Darwinian Revolution' represents a major challenge. The emergence of evolution theory is seen as one of the most significant developments within the life sciences, and as a classic example of how new scientific ideas can interact with broader cultural and social developments. University courses and textbooks often contain a substantial section on this topic, while the amount of specialized research in the area is so great that even the specialists themselves find it hard to keep up with the flood of publications. So many historians have devoted themselves to the minute study of Darwin's life and writings that we routinely use the phrase 'Darwin industry' to denote their activity. Yet in recent years we have become gradually more aware that the traditional image of the 'Darwinian Revolution' is an artificial one. We have changed our ideas about the character of the events centred on the publication of Darwin's *Origin of Species*, recognizing that earlier interpretations were too obviously shaped by hindsight. The fact that the synthesis of Darwin's selection theory with Mendelian genetics has achieved paradigm status within modern biology encouraged the creation of a historical model which assumed that events must inevitably have led in this direction.

An important part of the more recent revisions to this interpretation has been a recognition that the traditional image of the 'Darwinian Revolution' was a chauvinistic one, based on the assumption that what happened in the English-speaking world was somehow the most typical or most natural line of development within modern biology. If scientists outside the British and American communities reacted differently to the new ideas in evolution theory, their behaviour must be an exception or anomaly, to be studied, if at all, merely as an example of how things can go wrong when external factors distort scientists' judgement. In recent years we have been forced to recognize just how one-sided this evaluation is. Historians have become ever more distrustful of the supposed internationalism of science. We now realize that different national communities can develop very different research interests, dictated by the different social, economic and cultural environments within which they must work. American historians have become very keenly aware of how their own scientific tradition differs even from those of other countries in the English-speaking world (1), while the differences between the scientific traditions among European nations have become

1. See for instance Ronald RAINGER, Keith R. BENSON, and Jane MAIENSCHIN, eds., *The American Development of Biology* (Philadelphia: University of Pennsylvania Press, 1988).

especially clear in the area of genetics and evolution theory (2). As part of this growing acceptance of national differences, we have at last come to realize the extent to which our overall evaluation of the major advances in science has been shaped by our own environment.

In this paper I would like to outline what seem to me to be the most important changes of emphasis that have resulted from this new perspective. I would like to give you an insider's view of how a particular community of historians, mostly British and American, has revised its interpretation of the impact of evolutionism. To some extent this reinterpretation has come about through contact with historians from other countries, but I think there are still significant barriers separating the historians of different countries and different language-groups. British and American scholars communicate freely in this area and accept a common intellectual framework upon which to base their work. But links to scholars in other countries are extremely variable, corresponding I suspect to variations in the degree of affinity between the cultural milieu of the different scientific and historical communities.

My own work has largely concentrated on English-speaking scientists, with only occasional forays into other areas when I found material of related interest there. For this reason I have had little incentive to move outside the community of English-language historians, although I have always been pleased to respond to queries about my work from elsewhere. I gained my doctoral degree from the University of Toronto, and taught for several years in Canada, so I naturally built up many contacts with the extensive network of historians of science in North America. Since moving back to this side of the Atlantic, I have begun to build up contacts in Europe, but on a somewhat irregular basis. I find that I have more contacts with Italian and Scandinavian scholars than with those from other European countries, and I think this reflects common interests. Although I do not speak Italian, for instance, we 'speak the same language' when it comes to interpreting the history of evolution theory (3). My contacts with other European countries are more fragmentary, and here I tend to depend for my information upon British or American scholars who have made a special study of European science and have built up contacts in that area. I think I have had more enquiries about my own work from scholars in Eastern Europe than I have from those in, say, France or Germany — and those contacts go back long before the recent thaw in international relations.

My own willingness to challenge the myths about the 'Darwinian Revolution' has thus sprung more from an internal critique of the English-language historiographical tradition, which has made me aware of the extent to which that tradition was shaped by the unique pattern of development in Anglo-American

2. A pioneering survey was Thomas F. GLICK, ed., *The Comparative Reception of Darwinism* (Austin: University of Texas Press, 1974).

3. Italian scholars working on the history of evolutionism include Pietro Corsi, Antonello La Vergata and Giuliano Pancaldi.

science (4). From this perspective, recognizing the differences between the ways in which different countries have responded to the rise of evolutionism is merely a useful way of highlighting the extent to which British and American historians have allowed their interpretation to be shaped by the intellectual environment within which they were trained. My concern has been to show that our image of the 'main line' of development within scientific evolutionism has been conditioned by the current state of biology in Britain and America. If we are to understand the past in its own terms, we must abandon the urge to treat everything that does not lie on that 'main line' as a side-branch of no real importance. To the scientists of a hundred years ago, what we can now see to have been a blind alley may have looked like a promising research programme, and we simply cannot understand their behaviour unless we take their concerns seriously. Showing that the scientists of other countries did not necessarily make the same decisions as those now taken for granted in Britain and America is a useful way of pointing out that the conceptual development of science is not a linear advance toward an unambiguous knowledge about nature.

My critique of the conventional image of the 'Darwinian Revolution' has, I think, paralleled a growing awareness among English-speaking historians of the extent to which their interpretation of the past had been shaped by modern interests. Among professional historians of science, it is now taken for granted that we should not present the publication of Darwin's theory as the breakthrough which ushered in the world of modern evolutionism. Outside the ranks of the professionals, however, I doubt that the latest revisionism has gained much of a hearing. Darwin has been elevated to the status of a 'hero of discovery' and his exploits have taken on mythical overtones which determine most non-specialists' interpretations of the past.

The scientists themselves have a vested interest in preserving the metaphor of the 'heroes of discovery' — those great thinkers who saw through the fog of ancient superstition and erected the foundations of modern knowledge. Darwin falls naturally into this category because it is easy to see him as the key figure in the replacement of old-fashioned creationism with a modern, natural explanation of organic origins. Paradoxically the religious and moral thinkers who see Darwinism as a powerful agent of modern materialism find the mythology of the 'Darwinian Revolution' equally useful (5). It gives them a convenient target against which to aim their opposition, and allows them to claim that the scientific community has been subverted by dangerous materialists. In the English-speaking

4. For the 'orthodox' view of the history of evolutionism, see for instance Loren EISELY, *Darwin's Century: Evolution and the Men who Discovered it* (New York: Doubleday, 1958) and more recently Ernst MAYR, *The Growth of Biological Thought: Diversity, Evolution and Inheritance* (Cambridge, Mass.: Harvard University Press, 1982). My critique of this tradition is developed in Peter J. BOWLER, *The Non-Darwinian Revolution: Reinterpreting a Historical Myth* (Baltimore: Johns Hopkins University Press, 1988).

5. See for instance Gertrude HIMMELFARB, *Darwin and the Darwinian Revolution* (New York: Norton, 1959). For a more recent account of the impact of Darwinism on religion see James R. MOORE, *The Post-Darwinian Controversies: A Study of the Protestant Struggle to Come to Terms with Darwin in Great Britain and America, 1870-1900* (New York and Cambridge: Cambridge University Press, 1979).

world, at least, one faces an uphill struggle when trying to argue that Darwin's theory played a more complex role than we once imagined. One is arguing against a powerful cultural symbol, and few people wish to see their comfortable perceptions of such symbols undermined.

The conventional interpretation of the 'Darwinian Revolution' — accepted even by historians of science until only a decade or so ago — can be summarized as follows. Essentially there was no serious evolutionism before Darwin. Although Lamarck and a few other naturalists had dared to challenge creationism, their evidence was flimsy and they had no satisfactory explanation of how evolution might work. Conservative scientists had little difficulty in discrediting these unsatisfactory 'precursors' of Darwin. Darwin provided both new lines of evidence, from the study of biogeography and adaptation, and a new and more satisfactory theory, natural selection. Creationists tried in vain to stamp out this superior version of evolutionism, but were unable to prevent the scientific community from recognizing its advantages. Western culture as a whole soon assimilated the new idea, and late-nineteenth-century thought was dominated by Darwinian ideas, including an overenthusiastic application of the struggle metaphor in social policies (6). The only serious gap in Darwin's theory was his failure to recognize the need for a particulate theory of heredity. This was provided by the emergence of Mendelian genetics in the early twentieth century, leading to the synthesis with Darwinism which has dominated biology ever since.

That such an interpretation of the rise of evolutionism was a caricature has become apparent from the increased willingness of the biologists themselves to challenge the Darwinian orthodoxy from the 1970s onwards. But at the same time historians too began to realize that more or less every stage in the conventional sequence of development rested upon an oversimplification, if not an outright distortion of the facts. In their anxiety to create a model in which there was a straight line linking Darwin's discovery of natural selection to the emergence of the modern synthetic theory, biologists had created an oversimplified interpretation of the past history of their discipline. This remodelled every event to make it fit in with their assumption that only those theories still accepted today played any significant role in the development of evolutionism. Step by step historians have re-evaluated the various stages in the development of evolutionism, exposing the extent to which history has been manipulated to present modern Darwinism as the inevitable outcome of the drive towards objective knowledge.

To be fair, the scientists themselves must, almost of necessity, view history through hindsight. Theories which did not gain acceptance in the long run are, by definition, blind alleys leading away from the march of progress, best forgotten even by the historian. Any other policy runs the danger of implying that outdated ideas were worth taking seriously after all, thus undermining generations of hard scientific work. But those of us who are interested in what actually happened in the past cannot allow our thinking to be blinkered by hindsight. This is par-

6. The idea that 'social Darwinism' proliferated in late-nineteenth-century thought was developed in Richard HOFSTADTER, *Social Darwinism in American Thought* (revised edn., Boston : Beacon Press, 1959).

ticularly important when trying to assess the cultural impact of scientific ideas : how can we hope to understand nineteenth century 'social Darwinism' if we apply an anachronistic modern definition of 'Darwinism' ? But I would argue that even the scientists have something to gain from adopting a more flexible view of history. Many of the current debates in evolutionism seem to centre upon a revival of ideas that were taken seriously in earlier periods of the history of biology. The triumph of modern Darwinism has not been quite so complete as its supporters would wish. Those biologists who would like to explore alternative ideas need to be aware of the extent to which similar alternatives have been tried out before. By recognizing the complexity of earlier debates, we help ourselves to understand the implications of what is going on today within what is still one of the most controversial branches of biology.

Let me now run through the major areas in which our understanding of the emergence of evolutionism has changed.

First, the so-called forerunners or precursors of Darwin. It has long been recognized that Darwin was not the first to put forward the general idea of evolution. All too often, however, the pre-Darwinian transformists have been treated as immature versions of Darwin himself — naturalists who tried to put together an outline of the modern theory of evolution, but failed owing to lack of evidence or failure to appreciate the true nature of the forces that might act to change a species (7). Historians now reject the whole technique of 'precursor-hunting' since it necessarily involves the evaluation of past theories by modern standards. We recognize that the context in which many of the pre-Darwinian theories were advanced was quite different to that in which Darwin himself worked. Instead of trying to pretend that naturalists such as Buffon or Lamarck were merely 'failed' Darwins, we attempt to understand the very different conceptual framework which led them to think as they did.

Many of the most important pre-Darwinian theories were put forward by French naturalists, and it is not surprising to find French historians working actively to explore the context and structure of their ideas. One need only mention the work of the late Jacques Roger on Buffon and many other eighteenth-century transformists (8). At a more fundamental and controversial level, Michel Foucault forced us to confront the possibility of a major hiatus between eighteenth and nineteenth-century versions of transformism (9). Somewhat paradoxically, Foucault's iconoclastic technique produced results that a modern Darwinist might feel quite comfortable with. It can be argued that Darwin was indeed the first person seriously to explore the possibility that evolution was an open-ended, divergent process. He was also the first to see that evolution might be a process taking place within populations, not within individuals : the selection of random variation within a populations does not involve the summing up of changes

7. This approach to the pre-Darwinian period is evident from the title of Bentley GLASS *et al.*, eds., *Forerunners of Darwin, 1745-1859* (Baltimore : Johns Hopkins University Press, 1959).

8. Jacques ROGER, *Les sciences de la vie dans la pensée française du XVIII^e siècle* (Paris : Armand Colin, 1963) and more recently his *Buffon : un philosophe au Jardin du Roi* (Paris : Fayard, 1990).

9. Michel FOUCAULT, *Les mots et les choses* (Paris : Gallimard, 1966).

affecting individual organisms. On both these counts it might seem possible to justify the claim that a radical conceptual break separates pre-and post-Darwinian theories of evolution.

Whilst accepting that *modern* Darwinism does indeed require such a radical break with the past, more detailed historical work has, in fact, suggested that there is a much greater continuity between eighteenth and nineteenth-century ideas than Foucault's thesis would imply. The context certainly changed ; new ideas and new lines of evidence were explored, but Darwin's conceptual world did not constitute quite the radical break with the past that we once imagined. Recognition of this continuity arises both from an increased willingness to take seriously the transformist ideas of the early nineteenth century, and from a re-evaluation of post-Darwinian evolutionism.

At one time it was fashionable to assume that pre-Darwinian transformists such as J.B. Lamarck and E. Geoffroy Saint-Hilaire were largely ignored. This was supposedly due to the dominant influence of Georges Cuvier's more conservative interpretation of the history of life revealed by the fossil record. Recent studies have, however, revealed the extent to which French biology was divided by the issue of transformism, and have cast doubts on Cuvier's position as the final arbiter (10). The claim that modifications of individual development could transform species, thus accounting for the manifest relationships between the various organic structures, was not something that was so easily swept under the carpet.

Of equal interest to students of the 'Darwinian revolution' is new evidence that even in Britain, transformism was not a dead issue in the 1820s and 30s. Adrian Desmond has uncovered a network of radical anatomists centred on Robert Grant of Edinburgh, who made a determined effort to use the new French transformism as a weapon in their campaign against the conservative medical establishment (11). Grant was only discredited when the young anatomist Richard Owen succeeded in 'modernizing' the traditional concept of divine creation, thus stealing the radicals' thunder by showing that the latest techniques could also be exploited within a more conservative framework (12).

Along similar lines, Jim Secord has shown that the theory of progressive transmutation proposed in Robert Chambers' anonymously-published *Vestiges of the Natural History of Creation* of 1844 was an attempt to make the radical

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10. Tobey APPEL, *The Cuvier-Geoffroy Debate : French Biology in the Decades before Darwin* (Oxford : Oxford University Press, 1987) ; Pietro CORSI, *The Age of Lamarck : Evolutionary Theories in France, 1790-1830* (Berkeley : University of California Press, 1988) ; Dorinda OUTRAM, *Georges Cuvier : Vocation, Science and Authority in Post-Revolutionary France* (Manchester : Manchester University Press, 1984).
 11. Adrian DESMOND, *The Politics of Evolution : Medicine, Morphology, and Reform in Radical London* (Chicago : University of Chicago Press, 1989). See also Adrian DESMOND, *Archetypes and Ancestors : Palaeontology in Victorian London, 1850-1875* (London : Blond and Briggs, 1982).
 12. In addition to Desmond's work see also Evelleen RICHARDS, "A Question of Property Rights : Richard Owen's Evolutionism Reassessed", *British Journal for the History of Science*, 20 (1987) : 129-72.

ideas more acceptable to a public used to thinking in terms of design by God (13). Despite much initial opposition, Chambers' ideas did force both scientists and non-scientists to rethink their attitude toward transformism. The critical question was *continuity*: radicals and conservatives were both now beginning to think in terms of patterns unfolding by natural causes in the course of geological time, but where the radicals wanted a model of continuous development to support their calls for social reform, conservatives opted for theories with distinct cycles of development so that the cause of change remained unrelated to everyday activities (14).

It is now quite clear that Darwin did not introduce his theory to a public that was unaware of the issues. On the contrary, transformism had been a subject of hot debate for decades, and Darwin knew just how dangerous it would be for his social position if he were to be linked with the political radicals. At the same time, he was aware that the climate of opinion was changing. By the 1850s a new initiative on the subject of transformism would be welcomed by those who believed that God governed the world by law rather than by miracle (15). It would also appeal to a number of younger scientists who were losing patience with the claim that science must be subordinate to religion. Although it is true that religion figured in the British debates to an extent that would have been unthinkable in other countries, the possibility of non-miraculous change was beginning to seem less radical. But the simple appeal to preordained laws of development imposed by the Creator offered little hope of anything but a purely descriptive science of the past. If the idea of evolution by truly natural causes were to gain credibility, something other than the now-discredited Lamarckism would be needed. Darwin certainly provided a new initiative, but he was introducing it to a public that had already been conditioned to think of evolution as the unfolding of a purposeful trend toward a morally significant goal.

The amount of scholarly effort devoted to Darwin over the last few decades is phenomenal (16). His notebooks and diaries have been published, and the complete edition of his correspondence has now reached its sixth volume (thirty

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13. James SECORD, "Behind the Veil: Robert Chambers and the Genesis of the *Vestiges of Creation*". In J.R. MOORE, ed., *History, Humanity and Evolution: Essays for John C. Greene* (Cambridge: Cambridge University Press, 1989), pp. 165-94. On the non-Darwinian character of Chambers' theory see M.J.S. HODGE, "The Universal Gestation of Nature: Chambers' *Vestiges and Explanations*", *Journal of the History of Biology*, 5 (1972): 127-52.
14. See Peter J. BOWLER, *The Invention of Progress: The Victorians and the Past* (Oxford: Basil Blackwell, 1989).
15. See Pietro CORSI, *Science and Religion: Baden Powell and the Anglican Debate, 1800-1860* (Cambridge: Cambridge University Press, 1988).
16. For a survey see David OLDROYD, "How Did Darwin Arrive at his Theory?", *History of Science*, 22 (1985): 325-74. The best collection of modern Darwin scholarship is David KOHN, ed., *The Darwinian Heritage* (Princeton: Princeton University Press, 1985). See also Peter J. BOWLER, *Charles Darwin: The Man and his Influence* (Oxford: Basil Blackwell, 1990).

are projected) (17). Scholars play the role of detective, attempting to date letters and notes by the watermarks in the paper or by Darwin's spelling errors. An immense number of books and articles has been devoted to the question of how he developed his theory. There are many technical issues at stake here, but I shall mention only two of the more important.

The first relates to Darwin's views on reproduction, or as he would have termed it, 'generation'. Traditionally, the most influential aspect of his scientific work was supposed to be his biogeographical work arising from the voyage of the *Beagle*. This was certainly the source of his model of divergent evolution driven solely by the demands of adaptation to the local environment. Darwin's views on heredity were a source of embarrassment to his later followers: he had clearly failed to anticipate the insights of Mendelian genetics, and this had led to some difficulties with his scientific critics. But Jon Hodge has recently pointed out that to Darwin himself, his theory of generation or reproduction was an integral part of his overall view of evolution (18). Natural selection was, in effect, a process which mediated between the production of new characters through reproduction and the pressures of the external environment. However false his theory of 'pangenesis' might seem by modern standards, it cannot be separated from Darwin's understanding of evolution. And since his thinking on this topic was conditioned by existing ideas, we can see that his innovations extended only to one half of his overall theory. Natural selection as originally conceived was a combination of radical and conservative ideas — and it would be a generation or more before anyone proposed a truly radical alternative in the area of heredity.

This in turn leads me to a second topic, the much-argued question of Darwin's commitment to progressionism. Modern Darwinists certainly believe that the theory of divergent, adaptive evolution is incompatible with the claim that nature is steadily advancing towards higher levels of organization. There are certainly some anticipations of this position in Darwin's own writings, and it used to be fairly widely assumed that he had repudiated the link between evolution and progress. But careful studies of his notebooks and other writings have convinced many historians that, despite his warnings against simpleminded progressionism, Darwin did nevertheless accept that natural selection would, in the long run, produce higher levels of organization. He made sure that the concluding pages of the *Origin of Species* would reflect this view, thus guaranteeing that his theory would be seen to fit in with the prevailing faith in progress. Whatever his opinions as a biologist, when it came to exploring the social and moral implications of evolution, Darwin again fell in with the conventional attitudes of his time. At least one historian is now arguing that there was really very little difference between Darwin and other outright progressionists such as Ernst Haeckel and

17. Paul H. BARRETT *et al.*, eds., *Charles Darwin's Notebooks, 1836-1844* (London: British Museum (Natural History) and Cambridge: Cambridge University Press, 1987). At the time of writing, the project to reprint Darwin's correspondence has reached its sixth volume: Frederick Burckhardt and Sydney Smith, eds., *The Correspondence of Charles Darwin* (Cambridge: Cambridge University Press, 1984-90).

18. M.J.S. HODGE, "Darwin as a Lifelong Generation Theorist", in KOHN, ed., *The Darwinian Heritage* (note 16), pp. 207-43.

Herbert Spencer (19). I think this goes a little too far, but we do need to accept that the radical aspects of Darwin's thinking that are so important to modern biologists were embedded in a conceptual framework which was in many other respects quite conventional.

These reassessments of Darwin's own thoughts have major implications for our interpretation of the debate which followed the publication of the *Origin of Species* in 1859. The traditional view of this debate was that the superiority of Darwin's theory and of his evidence guaranteed the success of his campaign to convert the scientific community. Modern work certainly confirms that within a decade or so the vast majority of British and American scientists had accepted evolutionism (20). But it has become increasingly obvious that this was not because they accepted natural selection as an adequate explanation of how evolution worked, nor because they were convinced by the evidence from biogeography and the study of local adaptations. On the contrary, we now know that even leading members of the Darwinian party, including T.H. Huxley, were not good 'Darwinians' by the modern definition of that term (21). Huxley was a morphologist, a leading contributor to what became the most active area of evolutionary science, the attempt to reconstruct an outline of the history of life on earth. Most evolutionary morphologists paid little attention to biogeography (Huxley was an exception in this respect) or to adaptation. They often retained the image of a central trunk to the 'tree' of evolution defining the main line of progress towards mankind (22). Huxley never accepted natural selection as the chief mechanism of evolution, and preferred to think in terms of saltations produced by internally-directed variation-trends. He supported Darwin because the idea of natural evolution was an important feature of his campaign to establish science as a source of moral authority that would replace religion.

Although they would later come to disagree on the social implications of evolutionism, in the 1860s Huxley worked hand in hand with Herbert Spencer to ensure that evolution was seen as the foundation for a progressionist world view. Darwinism succeeded not because the *Origin of Species* convinced everyone by force of argument, but because the theory made a convenient figurehead for important changes that were taking place both within the scientific community and within society at large. In fact, we now know that far from dying away, the scientific opposition to Darwinism grew in strength during the later decades of the

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19. Robert J. RICHARDS, "The Moral Foundations of the Idea of Evolutionary Progress : Darwin, Spencer and the Neo-Darwinians", in Matthew H. NITECKI, ed., *Evolutionary Progress* (Chicago : University of Chicago Press, 1988), pp. 129-48 ; see also RICHARDS' *Darwin and the Emergence of Evolutionary Theories of Mind and Behavior* (Chicago : University of Chicago Press, 1987).
 20. See especially Alvar ELLEGARD, *Darwin and the General Reader : The Reception of Darwin's Theory of Evolution in the British Periodical Press, 1859-1872* (Göteborg : Acta Universitatis Gothoburgensis, 1957, reprinted Chicago : University of Chicago Press, 1990).
 21. See DESMOND, *Archetypes and Ancestors* (note 11) and Mario T. DI GREGORIO, *T.H. Huxley's Place in Natural Science* (New Haven : Yale University Press, 1984).
 22. See Peter J. BOWLER, "Development and Adaptation : Evolutionary Concepts in British Morphology, 1870-1914", *British Journal for the History of Science*, 22 (1989) : 283-97.

nineteenth century (23). Evolutionism was accepted, but the technical arguments against natural selection seemed so powerful that many biologists preferred to explore alternative theories to explain how the changes took place. Until recently, most accounts of the 'Darwinian Revolution' concentrated on the arguments against natural selection, but said little about the alternative theories that were suggested — thus continuing to focus attention onto Darwinism even while admitting that it was controversial. My own research for the last ten years or more has centered on an attempt to convince historians of science that the various anti-Darwinian theories should not be dismissed as an unfortunate lapse of concentration on the part of the scientific community. As things stood at the time, there were apparently good reasons, both scientific and philosophical, for exploring these alternatives.

An obvious point to make is that even some so-called 'Darwinians' preferred the alternatives to natural selection. I have already referred to T.H. Huxley's support for directed variation, and in the later decades of the century many palaeontologists preferred to explain evolution by the theory of 'orthogenesis', which assumed the existence of built-in trends forcing evolution in a predictable direction. By this time, the concept of directed variation was seen as an alternative, not an addition, to natural selection, and its supporters regarded themselves as opponents of Darwinism. Orthogenesis undermined what modern biologists see as the most crucial implications of the selection theory: evolution was determined, not open-ended, and it proceeded almost without reference to the demands of the environment. Yet this totally anti-Darwinian viewpoint flourished within palaeontology through into the early decades of the twentieth century. In this area, at least, biology did not take on board the most revolutionary aspects of Darwin's thinking. Palaeontologists were convinced that the fossil record displayed linear, nonadaptive trends in which whole groups of species were driven in parallel in the same directions.

Another alternative was the Lamarckian mechanism of the inheritance of acquired characteristics. Although once discredited, this began to seem more plausible once the general idea of evolution had been accepted. Some so-called 'Darwinians' used the mechanism to supplement natural selection, including both Herbert Spencer and Ernst Haeckel. In Spencer's case, I believe that natural selection was always subordinated to Lamarckism. Spencer has been called a 'social Darwinist' because he proclaimed that struggle was the driving force of progress. Yet he did not see struggle primarily as a means of eliminating the congenitally unfit; its real purpose was to stimulate organisms (including human beings) to greater efforts. Progressive evolution occurred through the summing up of individual acts of self-improvement among organisms striving to adapt to new conditions — a very Lamarckian viewpoint. I would argue that much of what has passed for 'social Darwinism' is really Spencerianism, and hence

23. See BOWLER, *The Eclipse of Darwinism: Anti-Darwinian Evolution Theories in the Decades around 1900* (Baltimore: Johns Hopkins University Press, 1983).

a form of 'social Lamarckism' (24). Before the advent of Weismann's theory of the germ plasm in the 1880s, I suspect that even biologists found it difficult to distinguish clearly between natural selection and Lamarckism. And of course Weismann's theory was intensely controversial at first — the concept of 'hard' heredity only began to gain wide support after the emergence of Mendelian genetics.

Equally important is the use of Lamarckism by biologists and social thinkers who set themselves up in opposition to Darwinism. Even in America there was a flourishing school of Neo-Lamarckism by the 1870s, with a number of palaeontologists arguing that use-inheritance offered a better explanation of the adaptive trends they discerned in the fossil record. Their enthusiasm for linear evolution led also to support for orthogenesis, so that Lamarckism and orthogenesis became the twin pillars upholding a totally anti-Darwinian view of evolution (25). Lamarckism was also taken up by moralists and social thinkers who believed that it offered a more humane vision of evolution in which animals could direct the future development of their species by making conscious choices of new behaviour patterns.

I have argued that much early 'Darwinism' was not very Darwinian by modern standards, and that the decades around 1900 saw an 'eclipse of Darwinism' in which many biologists and social thinkers opted for non-Darwinian theories of evolution. Acceptance of evolutionism in the late nineteenth century thus constituted what I have called a 'Non-Darwinian Revolution', because (by modern standards) it was based on models of development which excluded the more radical ideas that can be found buried in Darwin's own writings. The emergence of selectionism as the most influential theory of evolution is very much a product of the twentieth century, centered, I believe, on the restructuring of ideas about heredity and variation made possible by Mendelian genetics (26). Mendelism was at first seen as yet another alternative to Darwinism because it seemed more consistent with a discontinuous model for the creation of new characters. But the classical genetics of T.H. Morgan's school undermined the credibility of both Lamarckism and orthogenesis, thus creating a situation in which natural selection acting upon populations offered the only way of directing the flow of new genetic characters. The more innovative aspects of Darwin's theory could now, at last, be appreciated.

Some historians have objected to the more radical aspects of my attack upon the traditional interpretation of the 'Darwinian revolution' (27), but I think there

24. See *ibid*, chapters 6 and 7 and Stephen Jay GOULD, *Ontogeny and Phylogeny* (Cambridge, Mass. : Harvard University Press, 1977), chap. 4.

25. See BOWLER, *The Non-Darwinian Revolution* (note 4) and Robert BANNISTER, *Social Darwinism : Science and Myth in Anglo- American Social Thought* (Philadelphia : Temple University Press, 1979).

26. See Peter J. BOWLER, *The Mendelian Revolution : the Emergence of Hereditarian Concepts in Modern Science and Society* (London : Athlone / Baltimore : Johns Hopkins University Press, 1989).

27. E.g. Ernst MAYR, "When is Historiography Whiggish ?" *Journal of the History of Ideas*, vol. 51 (1990) : 301-09.

is now general agreement that the development of evolution theory has been a much more complex process than was once imagined. Darwin remains an important figurehead, but everyone now realizes that we need a far more sophisticated interpretation of his impact upon nineteenth-century science and society.

In conclusion I want to return to my introductory remarks about national differences in our perceptions of the history of science. English-speaking historians of genetics and evolution theory are now more aware of the differences which exist between the responses of various national scientific communities. We recognize that there were significant differences between the reactions even of British and American scientists : there was no British equivalent of American Neo-Lamarckism, and British genetics under William Bateson rejected some of the key insights of T.H. Morgan's school.

Even more illuminating are the differences between the various European nationalities. The French were not impressed by Darwin, and Mendelism also had to struggle to gain a foothold in early-twentieth century France (28). German Darwinism was not like its British equivalent, nor did German genetics take on the rigidly hereditarian outlook of the Morgan school (29). I am sure that many other examples could be cited. These national differences are important because they tell those of us who must work in the shadow of Darwin that we cannot trace out an obvious line of development leading directly from Darwin's own work to the modern synthetic theory of evolution. In recognizing that scientists did not respond uniformly to the challenge of evolutionism, we are forced to abandon the assumption that the development of science represents a steady advance towards universally valid knowledge of the world. Scientific knowledge may not be — as some sociologists of knowledge claim — merely a socially-constructed model of the world, but social and cultural factors have influenced the conceptual models that the scientists of different times and places have considered acceptable. The same factors have also influenced historians' views on the development of science.

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28. See Yvette CONRY, *L'introduction du Darwinisme en France au XIXe siècle* (Paris : Vrin, 1974) and R.M. BURIAN, *et al.*, "The Singular Fate of Genetics in the History of French Biology," *Journal of the History of Biology*, vol. 21 (1988) : 357-402.

29. See for instance Jonathan HARWOOD, "Genetics and the Evolutionary Synthesis in Inter-War Germany", *Annals of Science*, vol. 42 (1985) : 279-301 and HARWOOD, "National Styles In Science : Genetics in Germany and the United States between the World Wars", *Isis*, vol. 78 (1987) : 390-414 ; more generally see Jan SAPP, *Beyond the Gene : Cytoplasmic Inheritance and the Struggle for Authority in Genetics* (Oxford : Oxford University Press, 1987).

Summary

The conventional image of the 'Darwinian Revolution' has recently been challenged by a number of new historical studies. For example, it has been pointed out that eighteenth and nineteenth-century discussions on 'transformism', in particular on the Continent but also in Britain, should be taken into account when describing the emergence and reception of Darwinian evolutionism. Equally, the question of how Darwin developed his theory is in need of reassessment, which will also have important implications for the interpretation of the debate which followed the publication of *Origin of Species* in 1859. Acceptance of evolutionism in the late nineteenth century was often based on models of development (e.g. Neo-Lamarckian) which excluded the more radical ideas of Darwin. Finally, attention should be given to national differences in the reception of Darwin's work: