DARWIN AND DARWIN STUDIES, 1959–63[1]

BERT JAMES LOEWENBERG, Sarah Lawrence College,
Bronxville, New York

DARWIN biographers patiently remind us that Darwin was improperly educated and inadequately trained. He never learned to draw appropriately, and his competence in mathematics was nothing short of mediocre. The subject he admitted awed him, and he required special assistance whenever such knowledge impinged upon his needs. If he had little natural aptitude for mathematics, he had less bent for language. Although he acquired a working facility in Spanish as a young man and read French with ease, German mastered him. Like Joseph D. Hooker, he began it several times.

The catalogue of Darwin's deficiencies is seemingly as startling as it is endless. His own diffidence constantly induced him to amplify the list. He was forever telling his friends and correspondents that he was woefully ignorant of entomology, anatomy, botany or of whatever subject he was at the moment engaged upon. It is remarkable that he ever managed to survive intellectually. He is said to have had little historical sense, a defect to which he himself referred long before others affected to discover it, despite the fact that the *Origin* is among the greatest historical works ever written. While philosophy never ceased to excite his admiration, he disclaimed any real familiarity with it or the wit truly to comprehend it. When the publication of the *Origin* pushed him over the threshold of fame and made him a public figure, the proprieties of criticism made it conventional to applaud his scientific rigor and to protest his philosophical innocence. It is still conventional to laud his character while rejecting his science as unphilosophical and his philosophy as unscientific. A tyro in metaphysics, a term he used pejoratively himself, he is charged with logical lapses unworthy of a sophomore. Shockingly imprecise in expression, he enmeshed the future in semantic confusion, and the viciousness of his circular reasoning extended from the core of his argument to the perimeter of his thought.[2]

Darwin's scientific education is said to be as sparse as his general education was fragmentary. He had in fact no formal training, particularly experimental training, for which his elegant barnacles were certainly belated and presumably insufficient. Comparison with others, a favorite technique of critics, continues to titilate the ingenuity of historians and others who seek to comprehend his achievement. Richard Owen was a better anatomist, Karl von Baer a better embryologist, Sir Charles Lyell a better geologist. Robert Brown was his superior in botany, William Carpenter in physiology. Alfred Russel Wallace wrote with greater ease

and often with greater dexterity. The first great Huxley had inexhaustible reserves of energy and inexhaustible resources of talent and charm. Until 1859 there was hardly a well-known specialist whose learning was not reputedly greater. Even after the appearance of the *Origin*, which demonstrated the depth of Darwin's knowledge, there were many whose command of special areas exceeded his own. "Why was it given to Darwin", a hostile critic asks us to wonder, "less ambitious, less imaginative, and less learned than many of his colleagues, to discover the theory sought after by others so assiduously? How did it come about that one so limited intellectually and insensitive culturally should have devised a theory so massive in structure and sweeping in significance?"[3]

While Darwin's educational record was undistinguished, his maturity was clogged by the psychological ailments of youth. Glamor of distinction escaped him at school and university, and no apparent purpose metered his slumbering drives. Indecision seemed so conspicuous that he appears in most biographical accounts placid and apathetic, headed for a vagrant life of self-indulgence. He meekly obeyed a stern and domineering father who, having first commanded medicine, later buried paternal hopes and suggested the ministry, a counsel final in every sense. A neurotic thread entangled Darwin's future. His adolescent ego had not only to withstand an overweening father's projections, but the premature death of his mother left him at the age of eight under the care of a bevy of older sisters who coddled and overprotected him. Thereafter sickness, dating from before the "Beagle" days, afflicted his existence and became a persistent enemy disrupting, harassing and impeding him. He agonized about his own health and the health of his family. Prescriptions, disquisitions on cures and admonitory cautions clutter his correspondence and make up a sizeable batch of his literary remains.

The composite portrait of Charles Darwin faithfully reflects the classic lines of its origin. Sharply etched by Darwin himself in his recollections, they were filially preserved by his son, Francis, the first Darwin editor and historian. The outline, gradually accepted as basic for Darwin's early life, precipitates the inevitable question: How did he do it? Darwin's wealth precludes the notion of a self-made man, but Darwin's career suggests the notion of a self-made genius. The question, however, remains: How to account for the metamorphosis of an aimless young gentleman into the single-minded scientist? The assumed contradictions of Darwin's personality, warped by dependence and the cloying affection of unmarried sisters, poses additional questions: How was a person so stunted in adolescence, and later so neurotically involved in maintaining a semblance of health, to become one of the leading scientists of all time?

Darwin critics and Darwin proponents share these problems in common. The answers obviously differ. All suffer in varied ways from lack of completeness and a too-literal faith in scientific parsimony. To critics,

particularly negative ones, Darwin's haphazard education becomes the explanation of hesitancy and logical ineptness. Psychological maladies invade his mind and infect the sinews of his character. They explain not only weaknesses and inconsistencies. They mold a series of traits: diffidence, egocentricity, lust for fame and need for the support of others. If acceptance of the fact of evolution and Darwin's version of it remain obtrusive facts of history, it suffices to suggest that his controlling ideas, filched from the public domain, were not new. Before Darwin, the world was not ready; after Darwin the world was receptive. The hypothesis, if not incomplete, retained the ancient boundaries limiting his predecessors. If the concept of evolution is accepted, it is accepted less because of natural selection than other factors, less because of Darwin than earlier writers and less because of the discoveries of the Darwin era than because of later research.

Darwin advocates present different interpretations not, however, on different evidence. Captivated by the evolution idea and sympathetic to the man who established it, they accept the conventional reading of the data. Darwin's youthful indecision becomes arrested development; adolescent crises, instead of blocking him, are surmountable obstacles overcome by bursts of pent-up creativity. Darwin's life—his background, training, fame and impact—is often presented as the joinder of genius and fortuity. Genius, latent in hereditary patterns, requires favorable opportunities and these gradually combined to produce it. Time and place were always "ripe" for Darwin and ideas of evolution, during his formative years, were "in the air". Genius does indeed depend upon specific conditions as well as native endowments. It depends upon detailed cultural circumstances, partly accidental, of historical time and of geographical and sociological place. Darwin scholars, usually content to rest upon the dictum, have seldom woven concept and data together into convincing explanations.

Interest to be sure cleaves to the dramatic. Compulsion to reach the "Beagle", the *Origin* and the *Descent of Man* has prevented analysts from according the crucial years of Darwin's youth full critical due. The isolated facts, not the inferences deduced from them, are true in themselves. But gaps in the sequence of meaning frequently fail to satisfy and interpretations seem frequently warped.

If Darwin and Darwinism survive, it is largely the result of Darwin himself. "Every biologist", wrote one commentator on the eve of the Centennial, "feels that he wants to revere Charles Darwin, yet that somehow he cannot give unreserved admiration". Such judgments are as erroneous as notices of the death of Darwinism were premature. "Darwin's life and work have been endlessly studied", continues this observer, "but he remains a curiously ambiguous figure. Did he prove that evolution has occurred, or demonstrate its mechanism? Was he a

profound thinker and leader of a revolution in human thought? Do his technical contributions justify the title of the father of modern biology?"[4]

Darwin and Darwinism survive by absorption. Yet scholars can no more elude the impact of Darwinism than biology can escape the impress of Charles Darwin. Derek Price, discussing big *versus* little science, suggests the extent to which older research is cited with progressive infrequency. The infrequency curve abets historical amnesia except when earlier scholarship "actually improve[s] with age" or fits into a category of "name laws or name constants".[5] Darwinian evolution is, after all, Darwinian which insures Charles Darwin against the erosion of indifference. Darwin verified evolution; his successors succeeded in providing the amplest documentation. Darwin discovered a method to explain organic development; those who followed elaborated, refined and integrated it.

Biologists have written the most rewarding appraisals of Darwin.[6] Darwin historiography awaits assessment, but specialists in the life sciences have earned the historical laurels. Specialists have readily entered into Darwin's problems and passions, the earned increment of a sure grasp of evolutionary processes. They understand the elusive linkages in Darwin's thought, for they are psychologically involved in particular phases of it. Discriminations, even when excruciatingly technical, are discriminations which must be made, and they alone have been able adequately to make them. Darwin studies and Darwinian monographs provide a provocative source for leading aspects of modern thought. But Darwin studies have yet to demonstrate the extent to which Darwin's life exemplifies his concepts and Darwin's concepts refract his times. Specialism has built-in limitations of its own. Different men see things differently, and they see different things.

The literature of Darwin and Darwinism are prerequisite for the future of history; the Darwin Collection at Cambridge University is indispensable for the future of Darwin research. In 1942, the hundredth anniversary of Darwin's penciled sketch of evolution, the Darwin family and the Pilgrim Trust presented Cambridge with an incomparable body of material. Cambridge became the center of Darwin scholarship, for the gift represents an accession as vast as it is comprehensive. The Collection includes notebooks, memoranda Darwin addressed to himself, abstracts of reading, book lists, summaries of conversations, drafts and letters. Already there are upwards of 150 bound volumes of correspondence and other sources together with additional material boxed and partially indexed. The manuscript correspondence alone is greater than the five volumes of letters earlier printed.[7] But there is more: corrected proof sheets, early editions of Darwin's works and an incredible number of synopses, notes and random scraps.

This treasure trove has been twice augmented. A significant part of

Darwin's library, originally given to the Botany School by Francis Darwin in 1908, the centenary of Darwin's birth, has been deposited in the University, the result of a happy arrangement with Dr Harry Godwin, the Professor of Botany. These volumes are almost always marginally noted, frequently more fully on inside covers and fly leaves and occasionally enriched by copious abstracts on separate sheets. Finally, a vast collection of documents, formerly on deposit in the Library of the British Museum (Natural History), has been transferred to Cambridge. Among these materials are numberless letters addressed to Darwin as well as notes and abstracts in various stages of preparation. Other manuscripts are located at Down House, the British Museum, the Public Record Office, the Museum of the Royal College of Surgeons, the Museum of Natural History and Kew, but the bulk of extant manuscripts are now at Cambridge.[8]

The Darwin Collection has already justified the motives that made it available. While the measured prose of the *Origin* barely represses Darwin's excitement, the manuscripts register his irrepressible moods of exaltation and despair. They disclose a mind in the travail of self-discovery. They also disclose more than men are ordinarily willing to reveal. Apart from his correspondence, Darwin's papers are literally Darwin's. He wrote them to and for himself. He carefully preserved them because they were parts of his active research files constructed in preparation for his books. In July 1844, having just finished the second and larger sketch of his species theory, he wrote a solemn letter to his wife outlining a plan for publication in the event of premature death. He described a part of what became the Collection:

> I . . . request that you will hand over . . . all those scraps roughly divided in eight or ten brown paper portfolios. The scraps, with copied quotations from various works, are those which might aid my editor. I also request that you, or some amanuensis, will aid in deciphering any of the scraps which the editor may think possibly of use . . . . looking over the references and scraps will be a long labour. . . . Many of the scraps . . . contain mere rude suggestions and early views, now useless, and many of the facts will probably turn out as having no bearing on my theory.[9]

They are unencumbered by reticences, unmarred by any considerations save his own. He asks himself questions, he reminds himself to be cautious, he impales an adversary on the sharp point of an error in fact or logic, he notes a book to be read, a fact to look up, a suggestion to be followed. Alone with his thoughts, he spells out a fragment, trying it for intellectual shape and inner sound. One can imagine him reading a part aloud, and when crossed out, rejecting it, happily in many cases without obliteration. When irritation momentarily captures him, he

finds relief in the margin of a book, in a series of bold exclamation points, or escapes in the candor of an uninhibited comment. If distress or discouragment imprison his ardor, the obstacles are precisely set forth and countered with probable modes of extrication, the latter interspersed with dashes which, alas, he alone understood. When, enticed by an idea, his thought flows too swiftly for his pen, his writing trails off in undecipherable scrawls. According to Samuel Butler's computation, assuredly accurate, Darwin in the first edition of the *Origin* used the words "my theory" forty-five times.[10] But, if computations of this sort conceal the rumblings of a smothered ego, it might be profitable for other reasons to determine how often Darwin prefaces a comment with "Why should . . . ?", "How does it happen . . . ?", or "It is curious that. . . ." Whenever Darwin wonders why, or asks himself how, or is impressed by the singularity of a fact or a situation, he is on the brink of an insight or on the verge of a discovery.[11]

Some of this material has already been published. What has appeared represents a small fraction of the total; all of it is enlightening. Nora Barlow, Darwin's granddaughter, has produced an unexpurgated edition of the *Autobiography* which restores the deletions that Emma and Francis Darwin felt a decent respect for the reputations of certain Victorian personages demanded. Lady Barlow has also included informative comment on Charles Darwin and Erasmus Darwin, on the Darwin-Butler controversy and other data pertinent to the main and collateral themes. Her edition of Darwin's *Ornithological notes*, published in 1963 by the British Museum (Natural History), presents Darwin's observations made during the "Beagle" voyage, begun in 1832 and finished in March 1837.[12]

Fuller examination of the papers at Cambridge will establish accurate estimates of importance, but Darwin's four notebooks on transmutation will assuredly rank high.[13] Spanning the period from July 1837 to July 1839, they have been published under the editorship of Sir Gavin de Beer who has provided helpful introductions and full editorial notes.[14] The notebooks invite us to think Darwin's exploratory thoughts after him, to discover the books he read and where they led him, to see how his experiences generated ideas that became his own. They illustrate something of the texture of his mind, the method he perfected for ordering his endless probings and considered speculations. They likewise disclose the mature shape life had already given to his personality. They show us how he planned to write his book. "Argue opening thus", he tells himself, while on geographical distribution and species, for instance, he says, "give specimens of arrangement". A discussion of instincts is followed by the injunction, "my theory must encounter all these difficulties".[15] Analysis of the making of the *Origin of species* must absorb these data. All subsequent attempts to trace lines of contact between Darwin and his intellectual inspirations must be collated with

them. If the availability of these notebooks has not already outmoded much that has been written about Darwin's predecessors from published sources, they have at least made revision necessary.

An additional segment, prepared with the collaboration of M. J. Rowlands, concludes the undertaking with "addenda and corrigenda". Added are some of the "missing" notebook pages which Darwin periodically cut out presumably to make them more accessible for work immediately at hand. The corrections consist of alternative readings suggested by Dr Sydney Smith of St Catharine's College, Cambridge, since Darwin's handwriting, as he very well knew, sometimes defies ordinary optical equipment.

Smith has also demonstrated the abiding importance of the Collection. An essay on the "The origin of the 'Origin' " is a telling instance.[16] Comparison between Darwin's transmutation notebooks and marginal notes in his books, read between 1837 and 1842, shows that the grand idea probably did not occur to Darwin during the "Beagle" years. The conclusion has suggestiveness beyond the specific point. The "Beagle" voyage is no less "prelude to the *Origin*".[17] It is the essential preface, but the creative process of which it was part occurred later. The impact of Lyell and the "Beagle" consequence coalesce in Darwin's annotations. Specifically they join in the second volume of the fifth edition of Lyell's *Principles*, published in March 1837, and the pages of the transmutation notebook begun in July of the same year.

The creative years of discovery are those from 1837 to 1842; the years from 1831 to 1836 are prologue. After March 1837 Darwin was fully committed to the idea of transmutation. The hypothesis of descent with modification became "my theory" and "his grasp of the essentials . . ., though probably intuitive, was complete".[18] From 2 October 1836, when he landed at Falmouth, to 13 March 1837, when the first transmutation notebook was opened, are the critical months of discovery. Only then did he have adequate time for the examination of his specimens, for precipitating discussions in London and Cambridge, and for the catalysis of his New World experiences. Smith's conclusion not only satisfies the urge for accuracy; it conforms to what we know of the creative process. The manuscripts have significance beyond the *Origin* and its making. They possess significance for Darwin's entire existence, long before the advent of the "Beagle" and long after the *Origin* altered the intellectual history of the world.

To general queries about Darwin's predecessors, the manuscripts clearly respond. To ask whether the Darwinian revolution could have occurred without Charles Darwin is really to grant the historical point. There was a Darwinian revolution, and it could not have taken place without Charles Darwin. Even if it was true, as Professor Arthur O. Lovejoy argues, that the requisite data were available several decades before

Darwin, the argument was not convincingly presented until Darwin wrote.[19] Darwin, in Sydney Smith's persuasive language, "was a genius who took infinite pains—and twenty-two years—so that his theory would finally appear growing as a mature tree in the rich well-tilled soil of fact which sustains it to this day".[20] Historically the problem is not whether Darwin got there first but how he got there, a problem requiring emphasis not merely upon the "Beagle" and the *Origin*, but before the one and after the other.

Claims made for the Darwinian forerunners, formidable though some of them are, do not alter history. It was Charles Darwin, not Robert Chambers, William Lawrence or James Cowles Prichard who wrote the *Origin of species*. Robert Chambers, for whom a balanced brief is offered by Milton Millhauser in *Just before Darwin*, expertly summarizes pre-Darwinian science, but the *Vestiges* is not the *Origin*. Compared with Chambers, Darwin is distinguished as much for what he omitted as for what he included. If Darwin's victory is partly to be explained by what he included, Chambers's failure to convince his contemporaries is partly the consequence of what he was unable to leave out. For historians the cultural interim is controlling, the role of Darwin himself crucial. Changes in the ecological complex—which Darwin did so much to define, first for biologists then for sociologists and belatedly for historians—tip the scales of understanding.[21]

References to Lamarck, Lawrence and Prichard dot Lyell's pages. No one could have read the *Principles* as assiduously as Darwin without observing them. That Darwin studied these authors appears in "Notebook B", published by de Beer, and in the margins of the books themselves. And the books, annotated in varying degrees, remain in Darwin's library.[22] Articles by William Blyth, about whom Loren Eiseley has written,[23] are mentioned in "Notebook C", and after March 1838 Darwin read the whole file of the *Magazine of zoology, botany & continuation* in which they appear.[24] By this time Darwin had already made up his mind about transmutation, and it would have been somewhat odd had Darwin credited Blyth, who sought to prove the fixity of species, with having anticipated him. "Borrow" is a doubtful verb to employ in describing Darwin's use of Blyth's data, for the unpublished correspondence between them tells us only that information was frankly sought and freely given.[25] The Darwins, being what they were, could be expected to possess the works of Erasmus Darwin and Charles could be expected to read them. He read the *Zoonomia* several times on different occasions. As for Robert Chambers, abundant references and a noted copy of the *Vestiges* are preserved at Cambridge which Darwin read in late November 1844, after he had finished his second sketch of the transmutation theory, written earlier that year.[26] The dispute is judiciously summed up by Sydney Smith: [Once Darwin]

> received an immunizing dose of transmutation, to adopt a currently fashionable analogy, (he) was . . . well supplied with antibodies to similar ideas in other people's work when not accompanied by compensatory doses of solid information. It is partly on this account that Darwin has been accused of neglecting to show public recognition of his debt to his predecessors—but then so did Lamarck and most of the biological writers of the time.

Smith quotes three Darwin comments from Notebook "D":

> Seeing what von Buch (Humboldt) G. St Hilaire, & Lamarck have written I pretend no originality of idea (though I arrived at them quite independently & have used them since) the line of proof and reducing facts to law only merit if merit there be in the following work. In comparing my theory with any other it should be observed not what comparative difficulties (as long as not overwhelming) what comparative solutions and linking of facts.
>
> The line of argument often passed through my theory is to establish a point and a probability by induction and to apply it as hypothesis to other points and see whether it will solve them.[27]

And the information had to be solid. For example, Darwin wrote in the margin of H. G. Bronn's *Geschichte der Natur*; "Most of these observations vitiated by doubt of what are species, reason against my going into details".[28]

Even when touched by the genius of Maupertuis, a Buffon or a Lamarck, intimations of Darwin remain intimations.[29] Yet the greater the role assigned to Darwin's predecessors, the less novel Darwin's contributions appear. George Gaylord Simpson comments in a brief introduction to the reprint of Darwin's *Life and letters:* "Detailed attention to the background of Darwin's thought . . . seems almost determined to obliterate the foreground". And, he continues, mindful of those who would limit Darwin's stature by attributing too much to his precursors, "it is naive to proclaim as a 'discovery' that Darwin did not live in a vacuum and that he resembled everyone else who ever lived in that his ideas had origins".[30]

The foreground cannot be obliterated. But biologists in this instance are better historians than the professionals. They have not only succeeded in summarizing the evidence with a clarity rare among the technically expert, but they have analyzed the data in the perspective of significance. Darwin and Wallace stand alone.[31] No one save Darwin *developed* a theory of natural selection and creatively exploited it to demonstrate evolution.[32] Simpson's stricture that evolutionary intimations bear the same relation to Darwinism that space fiction bears to nuclear physics applies to many of the figures in Osborn's *From the Greeks to Darwin,* a volume more notable for its deficiencies than for its virtues. The

Simpson comment fits *Forerunners of Darwin* less aptly though it was Darwin, not Lamarck or Buffon, whose ideas transformed a world. Darwin, not Wallace, gave his name to an era as the result of a complex of historical factors. Neither Herbert Spencer, William Charles Wells, Patrick Matthew nor any of the German romantic philosophers became the symbol of the idea of evolution. Why Darwin succeeded and others failed is a question still fundamentally unanswered. Nor is it likely to be answered if attention is paid solely to an exegesis of documents without analysis of the historical context and the challenge of creative invention.[33]

The cycles of Darwin's growth can be traced in the Darwin manuscripts. The extant parts of the "longer version" of the *Origin*, for example—of which the *Origin* became the synopsis—is fundamental. Comparison with the earlier draft is obviously germane to the finished product; it is part of the history of transmutation and part of the history of Darwin's development. But, as Sydney Smith reminds us: "the first edition of the *Origin* has . . . come to be thought of as the beginning rather than as the culmination of the more than twenty-one years of reading, research and anxious thought. . . ".[34] Once the *Origin* is compared with this earlier version—and the earlier version with the *Origin*—Darwin's personal evolution, revealed in new dimensions, is creatively linked. Culmination directs us to look beyond the earlier manuscript to earlier experiences of which in turn the *Origin* was the consumation. When the edition now being prepared by Professor Robert C. Stauffer is completed, the data of the *Origin*, and therefore the *Origin* itself, will emerge in a wider scope of illustration, documentation and argument.[35]

Sir Gavin de Beer's biography of Darwin makes expeditious use of his own Collection productions together with those of others. One of the volumes of the "British men of science" series, of which he is the general editor, it is in every respect a noteworthy contribution. Authoritative, clear and incisive, it is the best brief study in the literature. While the earlier biography by Geoffrey West gives ampler coverage to the formative years, de Beer is incomparably superior in assessing Darwin's accomplishment in terms of modern knowledge.[36]

A trenchant study by C. D. Darlington carries the weight of a geneticist's reputation and an advocate's zeal. *Darwin's place in history*,[37] despite its brevity and its aggressiveness, is an important critical thrust. If Darlington is correct, estimates of Darwin's role must be revised and judgment of his character altered.

Darlington's indictment, no decorous argument for forgotten precursors, asserts that others had a surer grasp of the nature of evolution. Darwin borrowed their data and ignored their ideas. Accordingly, a "Darwin myth" obscures our vision, for Darwin's conduct, dubious to say the least, delayed the progress of sounder views and left a legacy of misconceptions. That Darwin's accomplishment induced acceptance, Darlington freely

concedes, but he rejects the reasons usually offered in explanation. Regardless of his data or his logic, Darlington performs a useful service to scholarship.

"Previous evidence", writes George Gaylord Simpson, "*did not* convince a majority of interested scientists; therefore it was insufficient for that purpose. Darwin's evidence *did* in fact convince them; therefore it was sufficient." Actually, such a formula beggars the historical question. It is far from obvious, as Simpson concedes, "why Darwin was the first evolutionist ever to carry conviction to a majority of his fellow scientists". "Climate of opinion" is an empty concept apart from specific and correlated data.[38] Darlington contends there is more than meets the roving historical eye. But a literally-minded definition of "evidence of science" may not be very helpful. The historical and conceptual relations of natural selection to the conquest of Darwinism alone are pertinent. Natural selection is not mooted nor is there any doubt that Darwin and Darwinism succeeded because of it. Darwin's use of natural selection and Darwinian dialectics are the crux of argument.

Darwin succeeded because he was wrong. The form of his errors and the factors that formed them are the major items in the Darlington brief. Any hypothesis of descent with modification required a theory of heredity, and Darwin adopted a "soft" theory. A soft theory "has a direction imposed on it *before* it arises, that is by the environment of the parent". A "hard" theory "has a direction imposed on it, if at all, only *after* it arises, that is by the environment of the offspring".[39] Hard theory controls the dynamics of natural selection. Darwin's approach in the first edition of the *Origin* is still, with elaborate ramifications, the approach of modern genetics. Darwin failed to retain his early attitude toward heredity and natural selection, shifting and qualifying from one edition to the other. Finally, in Darlington's view, "he did not himself know where he stood".[40] Since Darwin was uncertain whether natural selection or acquired characteristics was the prime mover of change, a directed evolution could be accepted with scientific impunity. Directed evolution implied cosmic purpose. Without the retention of a belief in purpose the doctrine of evolution would not have triumphed. Desertion of the concept of "hard" heredity explains the Darwinian victory. Darwin's espousal of blending inheritance is understandable since, like almost everyone else, he was unfamiliar with Mendel and particulate inheritance. Advocacy of Lamarckian principles, however, bolstered selection with intent instead of selection without it.

Yet the hypothesis of pangenesis was provisional, and a tentative acceptance by some of Darwin's colleagues suggests the dominance of blending theories.[41] Actually, Darwin, for whom heredity and variation were haunting issues, confronted some of the obstacles to his own formulation. He recognized "sports" or hereditary mutations and he

knew that "some characters refused to blend, and are transmitted in an unmodified state either from both parents or from one".[42] Darwin's notes, together with his breeding experiments on plants and animals, for example, are among his unremitting efforts to slay an elusive ghost. Scholarship is the history of men changing their minds, and Darwin's oscillations between hard and soft heredity may reasonably be ascribed to oscillations of attitudes toward complex and conflicting evidence.

Darlington's conclusions are provocative. Arguments for hard heredity and refutations of soft heredity were in the literary record long before Darwin began to write. Thomas Andrew Knight for the first time suggested something approaching the Mendelian principle of segregation, a suggestion exploited by Erasmus Darwin in *Phytologia* published in 1800. Charles Darwin, as early as his Edinburgh days, was introduced to the concept of evolution through the writings of his famous grandfather. In 1819 the *Natural history of Man* by William Lawrence appeared. Six years earlier James Cowles Prichard in *Researches into the physical history of mankind* wrote: "All acquired conditions of the body end with the life of the individual in whom they are produced. . . ."[43] These volumes were in Darwin's working library. His marginal notes and scorings reveal that he studied them. They are cited in Darwin's works—and cited for particular details, not for theoretical ideas or conclusions.

Why did Darwin ignore these ideas? Why, if impressed and stimulated, did he fail to indicate it? Darlington's answer is direct and simple: Darwin was guilty of deliberate suppression. He had a strategy, a strategy designed to offend no probable convert and to influence the final decision. Darwin was "slippery" and his behavior "cannot be reconciled with even average intellectual integrity".[44]

> . . . his ideas were less clearly sorted out and less clearly expressed, and, worst of all, less strictly and less openly held and maintained than the ideas of those who first thought of them. He never faced the cardinal issue of the evidence for or against the evidence of acquired characteristics, which is more important than the issue of whether evolution had happened. He was therefore able, as he put it, to 'wriggle'.[45]

The personal charge cannot, of course, remain unanswered. Nor can the history of Darwin and Darwinism, particularly because of the newly available materials, escape reassessment. If there is not a Darwin myth in Darlington's sense, there are still many questions which remain to be probed.

A correct theory of heredity was not the precondition of the Darwinian thesis. Genetical knowledge, on the other hand, brilliantly clarifies the mechanism of evolution as the lack of it aggravates its perplexities. Darwin's partial reliance on the efficacy of acquired characteristics was, in Simpson's opinion, an example of Darwin's use of "facts" since found

to be untrue. If "this particular Darwinian theory is now charitably forgotten", it is forgotten at the risk of understanding.[46] Darwin once petulantly remarked that "the history of error is unimportant", but he, like Simpson, was mistaken.

Gertrude Himmelfarb's *Darwin and the Darwinian revolution*,[47] a full-length analytical study written with practiced charm, surveys these twin subjects with beguiling fullness. Darlington's brief essay is an historical study written by a scientist. Himmelfarb's large volume is the work of a historian devoted primarily to Darwinian science. Yet Darlington's effort is likely to achieve a more lasting place in the Darwin literature because he raises issues so counter to the familiar grain. If Darwin deserted principle for expediency, he is not the Darwin of history. If in consequence, the basic assumptions of social inquiry are fallacious and imperil the future, different questions must be asked. Science may safely be left to the scientists. The implications of science for man and society are too important.

Something of the same urgency attaches to the Himmelfarb attempt. While her critique of natural selection fails, the correlative critique of modes of scientific thought, on ground philosophical and sociological, is part of the continuing dialogue between scientists and other scholars. This discussion, usually described as the controversy between science and humanism, has been presented in a library of volumes of which the most recent are Jacques Barzun's *Science: The glorious entertainment* and Floyd W. Matson's *The broken image: Man, science and society*.[48]

To this co-called controversy, Miss Himmelfarb's contribution is peripheral. Darwin and Darwinism are her dual themes. Save in matters of emphasis and detail, the Darwin figure emerging from these pages is strikingly similar to older portraits. Darwin's unpretentiousness, his unflagging commitment and his gentle nature, elicit sympathy, but Himmelfarb's stern disapproval of natural selection makes it hard to endow its author with greatness. It is harder to assign enduring significance to a revolution of fleeting import. Revolutions, even if transitory, must be capable of producing change. Since change there was, a problem of considerable magnitude remains. Natural selection, says Himmelfarb, "posing as a massive deduction from the evidence . . . ends up an ingenious argument from ignorance".[49] Some ingenuity is accordingly required to perceive in what sense there was a Darwinian revolution at all. Moreover, since such a comment is as appropriate to Harvey and Newton as to Einstein and Heisenberg, it is possible that inductions from ignorance have something to do with the method of science and the process of creative invention.

Otherwise the outlines of Darwin's career follow well-marked grooves. Except for the felicity of her prose, an occasional disagreement and the slight use of new data,[50] no novel questions are raised and no new

solutions offered. Darwin remains the aimless youth, the desultory student, the surrogate for his father's intent.

Isolated experiences will not suffice to describe the rhythms of growth. Contingencies of existence do not break the flow of life, they direct it. Insight cannot be defined as a "flash" which spontaneously leads confused minds toward the tranquility of understanding. A steady continuity of development links Darwin's life in unified wholes. Thought is a total process not divisible into dessicated segments of "fact" and "speculation", data and hypothesis, feeling and intellect. If we separate these phenomena as we mark time by separations on a clock or on a calendar, we do so for identical reasons.

To argue that there is an historical impropriety in viewing the "Beagle" voyage "simply as a prelude to the *Origin*" because "this would be to read history backwards",[51] betrays a misconception both of history and of personality. If history cannot be read backward, it can only be read forward. Actually, it can only be read backward and forward simultaneously. Every event develops a future which has relevance only in a present. And presents are the successions of futures which combine to create a past. The continuity between the *Origin* and the "Beagle", or between any other occurrences in Darwin's life, is certified by the fact that Darwin himself is the nexus between them: the "Beagle" experience is prelude to the *Origin* in every sense in which prelude has meaning.

The "Beagle" is to the *Origin* what Edinburgh and Cambridge are to the "Beagle". The historian's function is to unravel the obscure and sometimes hidden threads of organic relation. Whatever "flashes" of insight Darwin experienced during the making of the *Origin* and during the rest of his life, were ignited by both as well as by the smoldering experiences of all that went before. Whether the *Origin* could have been written without the "Beagle" is a question one may ask, but given the "Beagle" adventure, it can scarcely be considered "irrelevant".[52] And if past events were not contradicted by subsequent events—to that degree made irrelevant in the future—it would be difficult to discover what is meant by change or to understand what is meant by growth.

Once the *Origin* is reached in the Himmelfarb narrative the argument becomes the instrument of her animus. If her preface to the making of the *Origin* is dubious on historical grounds, her treatment of natural selection is incorrect on scientific grounds. The assertion that "the present status of Darwinism has not altered much since 1860"[53] is simply mistaken. Several volumes larger than Himmelfarb's large book would be required to list the research which, in every department of biology, refutes this statement. And it is pertinent to note that practically no serious biological work published since 1930 is cited. The startling discoveries of the last thirty years in genetics, paleontology, biochemistry or ecology alone, make the statement astounding.

A Darwin letter quoted on the same page on which this statement appears purports to establish Darwin's opinion that natural selection as "hard fact" remained unproved. The letter, addressed to George Bentham, the botanist, was written four years after the publication of the *Origin*. Himmelfarb omits the most important segment occurring before the concession which largely nullifies it. Of course, Darwin did not pretend that concrete, solid instances existed where he had none to offer. But he listed three general categories upon which credence might reasonably rest. Two of these reasons, and to a lesser extent the third, have been documented to the hilt by modern research.[54] "Evolutionary biology", writes Ernst Mayr, himself one of the notable contributors to contemporary understanding, "has never been closer to Darwin's original concepts than it is today".[55]

Mayr, whose review of Himmelfarb is a model of gentle restraint, is convinced that specialists have an obligation "to make the findings of evolutionary biology available to the non-specialists".[56] Sir Gavin de Beer and others agree, and there is no doubt that they are right.[57] Scholars, during the centennial year and since, have paid Darwin the greatest of tributes. They have sought to share their knowledge of the living world with those who live in it. If it is still possible to err, it is not because careful specialists have neglected the task. De Beer and Mayr are but two among many who have set forth recent findings with balance and lucidity. Their labors provide a partial answer to the threat of two cultures—if two cultures exist—for they have demonstrated that philosophers, literary scholars and historians can be verbally instructed in genetics and paleontology just as students of animal ecology can learn about population genetics and the biochemistry of gene behavior. Specialists in animal ecology may be better schooled for adventures in population genetics than philosophers; if so, it is an impressive argument for continued schooling.

Biologists have been uncommonly adept as expositors of technical research, more so seemingly than other specialists. George Gaylord Simpson's *Meaning of evolution*, for instance, cannot be compared with any general survey in economics nor can *Mankind evolving* by Theodosius Dobzhansky be equaled by any study purporting to introduce non-specialists to the field of government. N. J. Berrill's *Man's emerging mind* has yet to be matched by students of chemistry, physics or sociology and his *You and the universe* belongs in a class with George Gammov's *Biography of the Earth* and *One two three . . . infinity*. Marston Bates in *The nature of natural history* offers the credentials of understanding for the taking. These typical volumes intimate something about biology and biologists and the import of both for the endless study of man, his nature and his world.[58]

Monographs confirming Darwin's insights need only be read to avoid the

shoddy blunder of citing the geological record as a Darwinian weakness.[59] "The degree of perfection of the Geological record", Darwin told himself in a memorandum written before the *Origin*, "cannot be more than if a collector were sent for one day to Australia, Africa, America and Europe—and if that were to give us a notion of existing Fauna".[60] Imperfections inherent in the record, as Darwin in one of his best historical discussions described them, still remain,[61] but the evidence has been accumulated exactly as he anticipated. ". . . if we now possess in our cabinets anything near the whole series—then . . . my theory must be given up—but I am far from believing", Darwin wrote in 1842, "that we do nearly possess such a series".[62] Even the recalcitrant must be impressed with the series that can now be illustrated.

Recalcitrance, often the response of unimaginative demands for the observable and the concrete, must yield to Simpson's demonstration of the evolution of the horse. Simpson characteristically introduces his study of the horse with oblique advice: "From horses we may learn not only about the horse itself but also about animals in general, indeed about ourselves and about life as a whole, its history and characteristics".[63] The paleontology of the horse, Simpson reports, "is already so good that it is one of our best means of determining how evolution works",[64] a history he records in data so concrete that even the most critical eye must meet it. Multiple lines of equine development are illustrated in prose and picture, and the transition from species to species—even to the measure of time—established.

Search for links to reconstruct graduated series of transition were persistent during the Darwinian era. The very phrase "missing links", especially regarding man, alone became a refutation. And it is still occasionally asserted that evolution, particularly of man, remains "after a century of search, without the much-desired missing link . . .",[65] no more than a theory still. Such forensics defy the evidence accumulated during the last half century. It is now possible, as Sir Wilfrid Le Gros Clark affirms, "to illustrate by reference to comparative anatomical and fossil evidence, the gradual transformation of small generalized mammals similar to tree-shrews into the higher Primates, and even to Man himself".

> Although the fossil record is still far from complete, it is yet sufficient to allow us to link up one evolutionary stage with another in a natural sequence. The gaps which remain in this sequence are no longer of such an order as to demand any great effort of scientific imagination to fill them. . . .[66]

Louis S. B. Leakey, president of the Pan-African Congress of Prehistory, is the author of *Adam's ancestors: The evolution of Man and his culture.* He surveys the recent finds in Europe, Africa and Asia with the assurance of a participating expert. The volume is as valuable for graphic

descriptions of paleontological method and frank discussion of problems as for accounts of primary data. G. H. R. von Koenigswald, himself a discoverer of remains of *Pithecanthropus*, has written a clear appraisal of *The evolution of Man* and Ashley Montagu has made *Man: His first million years* and the *Biosocial nature of Man*, the envy of authors of cluttered prose. Raymond A. Dart, who first found *Australopithecus* in 1925, has composed an interesting account of *Adventures with the Missing Link* which includes his own discovery and those of others.[67] And few paleontologists can vie with George Gaylord Simpson whose bibliography is studded with monographs of research and expository studies.[68]

Darwin did not seek to establish the genealogy of human development in the *Descent of Man*. He sought instead to establish from the evidence available that man, like other forms of life, arose by descent through modification. Granted the validity of the process of natural selection, it was equally valid for man. Darwin was satisfied that the future would amplify his evidence and that additional confirmation would vindicate his conclusions.

Man's self-interest accounts for the "fiery ordeal" to which, in Darwin's phrase, the *Descent of Man* was subjected. Self-interest also accounts for the sustained interest in man's antecedents and man's nature. Yet modern man has learned, as did Darwin, to look with "pride at having risen . . . to the very summit of the organic scale" and to derive "some hope for a still higher destiny in the distant future".[69] Unlike many of Darwin's contemporaries, his followers agree that "he who has seen a savage in his native land will not feel much shame if forced to acknowledge that the blood of some humble creature flows in his veins".[70]

The mysteries of genetics like the mysteries of missing links have partially yielded to clear scientific reportage. Geneticists have made it irrefutably plain that the science of heredity, however much it complicates the mechanisms of evolution, finally succeeds in elucidating the total process. Genetical knowledge, in the crisp words of Ernst Mayr, constitutes "the causal basis of the Darwinian theory", a variant of Dobzhansky's dictum that "mutation and sexual reproduction supply merely the raw materials from which evolutionary changes are shaped by natural selection".[71] And Sir Ronald Fisher whose *Genetical theory of natural selection*, recently reissued, caps the genetical climax with the remark:

> Darwin's chief contribution, not only to Biology but to the whole of natural science, was to have brought to light a process by which contingencies *a priori* improbable, are given, in the process of time, an increasing probability, until it is their non-occurrence rather than their occurrence which becomes highly improbable.[72]

If this is "an ingenious argument from ignorance", then there is no science

and no creative thought. But there is history, and Sir Ronald's generalization from the data of genetics is confirmed by the data of history. To distort this hypothesis is to confound both history and biology; to misunderstand it renders comprehension of the method and the philosophy of science unlikely.

Those for whom multiple theories of causation are uncongenial, find it difficult to accept genetic factors as explanations of stability and change alike. "Persistence without change", helps to explain natural selection instead of refuting it. Genetic recombination produces variation; infrequency of mutation and persistence of genes re-enforces stability. Random critics who seek data to annihilate natural selection without benefit of genetics would do well to measure their hostility against the statement of I. M. Lerner. Following a brilliant analysis of selection in the Darwin commemorative volume, sponsored by the American Philosophical Society, he comments, "Evolution is the most fundamental biological law yet discovered. Natural selection is the basic mechanism implementing it".[73]

Biologists in general and geneticists in particular have tried to convert the theoretical postulates of heredity into comprehensible language. The growth of knowledge, perhaps more rapid in genetics during the last thirty years than in other biological fields, makes the need imperative. Scholarly concern is also sustained because of its immediate relevance to the human situation. Modern genetic theory has largely removed Darwinian difficulties and revised understanding of the manner in which natural selection operates. Natural selection, to cite a single point made by Mayr, "is inseparable from variation, its raw material, and in the understanding of variation great progress has been made since Darwin. What is evaluated by selection is not a mutation, not a 'naked' gene, but the finished organism that results from the interaction of all its genes".[74] Again, as Simpson puts it, "new organic characters, variants and new structures arise by mutations in populations. The frequencies of particular characteristics and, what is even more important, of their combinations, result not only from mutation but to an even greater extent from processes involved in the reproduction of the population".[75]

The centennial efforts of biologists reflect a zeal for the dissemination of ideas no less than a zeal for Darwin. Ernst Mayr, whose scholarship has stimulated readers without and within his discipline, has written a pertinent introduction to a facsimile reprint of the first edition of the *Origin*, a service the more welcome since the first edition is so valuable and so rarely reprinted.[76] Sir Gavin de Beer wrote a perceptive foreword to a compilation including the Sketch of 1842, the "Abstract" of 1844 and the Linnean Papers of 1858, a boon to students as the first two items have not been reprinted for half a century.[77] Sir Julian Huxley, successor to his grandfather as a Darwinian advocate, has been involved

in virtually every Darwin project. A reprint of the sixth edition of the *Origin* carries his introduction and he has also compiled a selection *Struggle for life.*[78] Darwin's *Life and letters*, out of print since 1887, has been republished with an introduction by George Gaylord Simpson. Marston Bates and Philip Humphrey edited an excellent *Darwin reader*[79] and Ashley Montagu has prepared the pioneer study of Thomas Henry Huxley, *Man's place in nature*, for more convenient use.[80] The "Natural History Library", an important publishing venture in co-operation with the American Museum of Natural History, includes a reissue of *The voyage of the Beagle* annotated and introduced by Leonard Engel.[81] Morse Peckham's variorum edition of the *Origin* has finally eliminated a source of confusion. Seventy-five per cent of the 3,878 sentences in the first edition were re-written from one to five times. "There are", Peckham reports, "thousands of sentence variants of crucial significance".[82] At last we are able to determine what Darwin really said and when in terms of the *Origin* he said it. There can no longer be any excuse for citing editions at random. The care, patience and devotion with which the work was done merits the highest praise.

Several collections and reprints, intimately related in subject matter to Darwin studies, are now at the disposal of students of evolution. The first edition of the initial essay on population by Thomas Malthus appears as an Ann Arbor paperback sympathetically prefaced by Kenneth E. Boulding; selections from the *Natural theology* by William Paley is an item in the "Library of liberal arts" introduced by Frederick Ferre.[83] Francis Galton's *Hereditary genius*, reprinted with an important commentary by C. D. Darlington, is as consequential for Darwin and evolution as for Galton and genetics.[84] An abridged version, by Leslie A. White, of E. B. Taylor's *Anthropology* is a fitting companion to Lewis Henry Morgan's *Ancient society*, newly edited and annotated by Eleanor Burke Leacock. William Graham Sumner is represented by a reprint of *Folkways*, still fundamental as a significant document in the history of ideas, and by two paperbound volumes of selections from his writings. One of these contains a suggestive though brief essay by Maurice R. Davie, who probably understands him better than anyone else; the other, *Social Darwinism*, is a selection of essays judiciously made by Stow Persons, who contributes an introduction and notes.[85] The title, unfortunately already a standard label, is regrettable. Since there is no category of thought which may be called "Social Darwinism", it is a phrase from which scholars should abstain. Relativity is also a pervasive word with obvious referents, but "Social Einsteinianism" bears no more substantive relation to the physics of Einstein than "Social Darwinism" bears to the biology of Darwin.

General surveys supplement the monographs and the editions of sources, selections and classic works. In *A hundred years of evolution*, G. S.

Carter briefly presents the historical narrative from the geological revolution of the eighteenth century to the revolution implicit in contemporary knowledge. Within the self-imposed limits of time and substance, it is the best single volume of its kind. Garrett Hardin's *Nature and Man's fate*, a much fuller account, is written informally and with bounding spirit. Particularly edifying are the sections dealing with the years since the *Origin* and the treatment of the dramatic innovations of our own day. Darwin himself, due to reliance upon usual sources, is less well handled; the connections between his life and thought are especially barren.[86] *The evolution of Life* by F. H. T. Rhodes traces the development of terrestrial existence from the beginnings to the advent of man and his kind. Rhodes succeeds in conveying the feeling of movement, the exciting spectrum of evolution, and the sense that it is intimately our own. A synthesis of the theory of evolution comes from J. Maynard Smith, a lively effort to traverse the entire field that greater numbers may know "what the world is like and how it came to be. . . ".[87] The same end is reached from a different point of departure in John Tyler Bonner's *The ideas of biology*. Bonner is concerned with "the ideas rather than the facts of biology" which he describes by way of cells, evolution, genetics, development and man. A. Hyatt Verrill has written a short but masterful summary of the whole subject called *The strange story of our Earth*.[88]

Scholars combined to honor Darwin in collaborative volumes and special issues of learned journals. *A century of Darwin*, edited by S. A. Barnett, is a collection of essays superior alike for content and authorship. C. H. Waddington, A. S. Romer, Sir Gavin de Beer and J. Heslop-Harrison write respectively on evolutionary theories and Darwin's relation to the fossil record, to embryology, to man's descent and to botany with specialist erudition and historical poise.[89] "Everything", writes Waddington, "has a history; it is its history which has moulded its character, and it is in terms of its history that its nature is to be understood", a generalization which he goes a long way to establish in distilling theories of evolution.[90] His cogent explication of genetics is followed by the remarkable exposition of Dobzhansky in a chapter significantly called "Species after Darwin". Capricious debate about Darwin and theories of heredity may perchance be stilled by the unequivocal statement: "A satisfactory understanding of the nature of species was simply unobtainable in Darwin's day. It had to wait for the development of a then non-existent biological science, namely, genetics".[91] Special attention should be called to "The third stage in genetics", by Donald Michie, in which, following a summation of experimental results, he concludes that there are certain elements "which make Darwin's pangenesis theory seem remarkable for its time".[92] Romer's "Darwin and the fossil record" is a veritable gem of thoughtful

compression and de Beer's presentation of Darwin and embryology is in every way its equal. Le Gros Clark on man's descent is as exciting as his subject, and the other essays match these high standards. These authors together with their associates reflect the fertility of Darwinian ideas in their own.[93]

Inspired by a slightly different *motif*, *Darwin's biological work* is a venture in reconsideration. The contributors intend to redress the public balance on two counts. First, they wish to recall that Darwin's greatness rests on the quality of his mind and the quality of his work from which biologists have "freely and profitably" drawn. This assures Darwin his unequalled place in the history of biology, not the "ignorant controversies which have become popularly associated with his name". Secondly, notwithstanding the unity which evolution gave to all Darwin's work, it is both necessary and proper to remember that he was a notable geologist, that his investigations embraced the whole range of biology and that his experimental work was "by no means unimportant".[94]

The editor, P. R. Bell, has skilfully organized a splendid book. His own chapter, on the movement of plants in response to light, revives Darwin's experimental contributions and explains how they informed the later growth of plant physiology.[95] J. B. S. Haldane's brilliant discussion of natural selection is enhanced by restrained speculation and a detailed analysis of genetics.[96] P. Marler's study on animal communication is an unalloyed pleasure: urbane, controlled and learned. To this subject, compelling in itself, Marler adds the clarity of impeccable organization. For fifty years after Darwin, investigation of animal behavior remained in much the same state. When it was resumed, only Sir Julian Huxley and possibly Konrad Lorenz[97] exhibit any direct indebtedness to the *Expression of the emotions in Man and animals*. Darwin knew little about the behavior of animals in the state of nature, and among domesticated animals he was best informed about dogs. Yet, as Marler concludes, Darwin's judgment stands confirmed. Human speech "does not offer an insuperable objection to the belief that man has developed from some lower form".[98] H. L. K. Whitehouse presents a full-scale paper on Darwin and cross- and self-fertilization in plants. Among other things he shows the limitations of an absence of genetic theory. Despite advances in the eighty years since the writing of Darwin's botanical books, many are reared upon them. If Darwin failed to "understand the causes of inherited variation", he believed correctly that "the advantages of cross-fertilization could be related to such variation".[99] A comparison between the evolutionary theories of Buffon, Lamarck and Darwin by J. S. Wilkie serves as a fitting climax for this first-rate volume.[100]

Scholarly journals celebrated Darwin and Darwinism in special commemorative issues. The Darwin issue of the *Antioch review*,

published by the Antioch Press, Yellow Springs, Ohio, contains a stellar article by Dobzhansky which recapitulates his enlarging views.[101] The Darwin issue of *Victorian studies*, published in Bloomington, Indiana, includes a piece by Morse Peckham, editor of the variorum text of the *Origin*, in which he reflects on the historical and semantic problems latent in attempts to reconstruct the Darwinian impact.[102]

In order to re-examine the impact and the issues, representatives of the learned world gathered together in assorted conferences, discussion groups and conclaves of celebration. Brief encounters between diverse minds and formal papers were of course more significant than ceremonial. Darwin would have been stirred by the novel concepts and the novel facts. But "without a grounding in elementary genetics", in Haldane's opinion, he would certainly have missed some of the theoretical refinements of argument.[103]

With professional stress on the evolution of man, the Washington Anthropological Society sponsored a series of centennial discussions and papers. The culminating volume, *Evolution and anthropology*, begins with Ernst Mayr's "Darwin and the evolutionary theory in biology" in which a primal distinction between typological thinking and population thinking is properly underscored. Substitution of typological for population thinking is a major consequence of the Darwinian revolution. "For the typologist, the type . . . is real and variation an illusion, while for the populationist the type (average) is an abstraction and only the variation is real".[104] Two studies deal with physical anthropology, two with archeology and one each with language, social organization and the emergence of the self.[105] Leslie A. White weighs the controversies among anthropologists and measures the impact of evolution and the late Clyde Kluckhohn concludes with a probing summary chapter.

The most elaborate symposium convened under the auspices of the University of Chicago where an assemblage of scholars from many parts of the world met in five-day session. The results are published in a report of three volumes.[106] It is a massive collection of forty-five papers and five panel discussions reaching a staggering total of 1,384 pages. Spectacular, however, is not its bulk but its significance. A galaxy of experts in most fields of evolutionary biology assembled in one place is unique in itself. These volumes are certain to make their historical mark as a record of specialist thought in the century after Darwin.

Sir Julian Huxley opens the proceedings with a lecture on "The emergence of Darwinism", followed by a disquisition on the evidence of inorganic evolution by Harlow Shapley. Two Chicago biochemists, Hans Gaffron and E. A. Evans, Jr, strive to superimpose order on the data regarding life's origin and viruses and evolution, respectively. A calculated tentativeness is the measure of their attainment. "The laws of evolution", a framework for which anthropologists and sociologists

yearn, are presented by Bernhard Rensch. Most of the essays provide a résumé of research in the specific area of treatment and in cognate fields. Simpson's "History of life" illustrates this tactic. He has covered this subject many times, always with fresh enthusiasm.[107]

Two studies in genetics follow these background essays. E. B. Ford writes briefly and authoritatively on evolution in progress, a phrase to be interpreted in both senses; "The comparative evolution of genetic systems" by G. Ledyard Stebbins[108] is a study in depth of the discipline which goes by this name.[109] In the "Evolution of flowering plants", Daniel I. Axelrod[110] reviews "current ideas on . . . varied aspects of flowering-plant evolution, with emphasis on the development of modern patterns of distribution".[111] The purpose of Alfred E. Emerson is "to re-evaluate some of the aspects of the role of populations in modern evolutionary theory". The study furnishes an example of the continuing debt biologists owe to Darwin and the direction toward which his conclusions propel them:

> Darwin came fairly close to the modern interpretation of the group system of the social instincts when he pointed out that the 'neuter' or sterile castes must have arisen through the selection of the whole entity. He acknowledged that the evolution of non-reproductive castes was the greatest special difficulty that his theory of natural selection had encountered and that this case also refuted Lamarck's concept of the inheritance of acquired characteristics. He did not, however, adequately apply natural selection to whole group or population units in contrast to his theory of natural selection of individuals.[112]

Broad-based articles on genetics are required for well-proportioned collections of "Darwiniana". *Evolution after Darwin* sparkles with explanations, queries and data presented by Ford, Stebbins and Emerson. To these Mayr, Waddington, Dobzhansky and Wright have added many pages of their own. They make the first Chicago volume an item likely to render service to future scholars; it is unlikely to serve the time-dishonored practice of honorific citation.

Mayr's "Emergence of evolutionary novelties", an intellectual exercise of high order, is mandatory for Darwin students. Darwin's adversaries pressed hard at the emergence of novelty for which natural selection by itself is inadequate to account.[113] St George Mivart pressed particularly hard and Darwin, in the sixth edition of the *Origin*, felt constrained to respond. The degree of Darwin's involvement is illustrated by his correspondence and his eagerness to reprint Chauncey Wright's pamphlet in Britain. It is more fully evidenced by the annotations in his copy of Mivart's *Genesis of species* and the analytical index he made. But without an awareness of distinctions between phenotype and genotype, the code

is indeed difficult to break. Mivart's saltationist position is understandable, as are Darwin's rejoinders. But the revival of such argumentation in the present is without defense.[114] Mayr's portrayal of the stages of thought by which such acquisitions are clarified—genetic, morphological, functional—is a marvel of synoptic lucidity. Darwin, here as elsewhere, pushed to the outermost boundaries of possibility and came as close to an explanation as the organized knowledge of the period allowed.

If, among experts in various branches of evolution, there is some concern about the prevalence of genetic interpretations, there seems little indication of waning.[115] Waddington's topic is the origin of adaptation in which he illustrates with ample detail and luxuriant argument that "all characters of all organisms are, after all, to some extent acquired characters, in the sense that the environment has played some role during their development". Lamarck's language and Lamarck's ideas receive close scrutiny. "All organisms are to some extent hereditary, in the sense that they are expressions of some of the potentialities with which the organism is endowed by its genetic constitution".[116] Waddington's objective is to restore "to the conventional picture" aspects which have been neglected and to provide "a more convincing explanation of how the appearance of design comes about".[117]

Dobzhansky addresses himself to the questions: "What agencies make the evolutionary changes in a group of organisms follow parallel paths, and which make them diverge?"[118] Apart from Darwin's formulations and apart from the pivotal nature of the query in relation to the processes of natural selection, its larger implications emerge at once from Dobzhansky's statement: "Nothing in the known history of life compels one to believe that evolution is predetermined or that organisms are able to change in just one direction". No environment is precisely the same nor does the genetic endowment remain constant. "Natural selection has no foresight. . . ".[119]

Population dynamics in Darwin's theory, according to A. J. Nicholson, has been largely neglected and his paper is constructed to fill the gap.[120] Darwin was actually aware of the function of sheer numbers, of the causal power of "checks to increase", and the delicate interdependence of living populations. Nicholson's conclusions, drawn to a considerable extent from laboratory experiments with the blowfly, confirm, with many discriminations, the respective concepts of natural selection held by Darwin and Wallace.

Everett C. Olson strikes a mild note of caution. Few deny the general concept of evolution—though a few there undoubtedly are—yet all would hesitate to embrace the dominant interpretations of how evolution works. There is not much justification for the persistent use of the definite article preceding various formulas of evolutionary mechanism—*the* selection theory, *the* theory of evolution—which confines those with

reservations to a silent minority or immunizes them by invidious comparison. Science pays an exorbitant price for silence and "there can be no excuse for failure to scrutinize and examine the structure for flaws. . .". Particularly is this true in the circumstance "where the total consists of parts, none of which is in itself completely verifiable but gains strength from the others. . . ".[121] Von Bertalanffy's well-known comment appears to be as apt to Olson as to others who participate in his mood. "A lover of paradox could say that the main objection to selection theory is that it cannot be disproved." Olson proceeds good-naturedly and with many evocative criticisms to look at the evidence of paleontology and morphology again. A type of conformity apparently exists within biology.

> Radical lines of investigation may open up new possibilities of approaching some of the problems that now seem untouchable . . . it will require persons able to think in radical terms, outside the current framework. . . . If the doors to unorthodox thinking and a place for the 'sport' is held in the society of biologists, undoubtedly persons with at least the will to try will appear.[122]

Four more essays complete the first volume. C. Ladd Prosser describes some of the relations between evolutionary theory and comparative physiology. Natural selection, he asserts, operates upon "environmentally induced variation". And "what is selective is not the changed state per se, but the capacity for change. Genetic change is random, and evolution is non-directed . . ., yet natural selection is full of direction, and by understanding the environment-cell interaction, the physiologist may supply important clues to the molecular mechanics of natural selection".[123] N. Tinbergen illumines the difference in purpose between classifiers and evolutionists, which, when confounded, often produced disputes and misunderstandings. He draws his data largely from the behavior of birds and concludes that, when the proper distinction is made and classification is employed as an aid to evolutionary history, a clearer knowledge of divergence results.[124]

Ecology and evolution is the subject of Marston Bates. Impoverishment is the consequence of too rigid a separation between the concept of organism and the concept of environment, as true in the study of populations and communities as in the study of individuals. Knowledge of community behavior has lagged in comparison with knowledge of populations and individuals. One reason is to be found in the complexity of community behavior; another that data on individuals and populations are prerequisite. When more studies are undertaken in this area, Bates believes, we shall have a firmer grasp of ecology which, after all, is but another name for natural selection.[125]

The dramatic unity and intensity of the *Evolution of life* is not sustained in the succeeding volume. Remarkable in a compilation by nature

uneven, the first volume rarely loses its momentum. "Mind, culture and society", the words of the subtitle of *Evolution of Man*, are no less vital than "origin, history and future", the language of the subtitle of *Evolution of life*, but the contrast between the two volumes is sharp. Neither the authors nor their contributions are responsible. Nor is it a characteristic of the subject matter sometimes said to proceed on different methodological principles and techniques. The contrast lies in balance and the failure to build specifically on the foundations already so well grounded. The first volume is intrinsically excellent, a great book of science and a great book of history. The second volume, a solid accomplishment, requires the first to give it permanence.[126]

The final volume, *Issues in evolution*, reprints the panel discussions of which there are five: The Origin of Life, The Evolution of Life, Man as an Organism, The Evolution of Mind, and Social and Cultural Evolution. The discussions, totalling almost two hundred pages of print, are based on a prepared agenda of issues which emerged after an interchange of papers, revisions and criticisms. Each of the forty-five participants, the members of the committee and other scholars participated in defining the broad topics and in preparing a detailed outline to which discussion is addressed. Another focus of analysis conditioned the discussion. Each specialist undertook to report on the particulars of the discipline in terms of evolution.

The volume is thus a cross-section of evolutionary biology. Historically it is invaluable; a response of representative experts to questions evoked by rethinking and strained through other minds who first listened to the original presentations and then critically examined them. For the participants the panels were exciting experiences in scholarly self-examination. For eager learners of any age or status, they remain an authoritative source for definition and information. But for consumption by the generally educated public, without the background of the prepared papers and the background of training, they are frequently too specialized. When conscious of their role as educated experts speaking to educated laymen, they are sometimes halting and inconclusive; when stimulated by the clash of ideas or a novel viewpoint, professional conditioning often stimulates an unrestrained flow of professional idiom.[127]

To communicate complicated ideas in uncomplicated prose is the mark of talent. Darwin possessed such talent in full measure. And it is a curious fact, to use a favorite Darwinian phrase, that one said to be so deficient in education, taste and sensitivity should have written the *Origin of species*. Darwin's literary performance in the *Origin* remains unmatched in modern scientific literature, but many books and papers are in the Darwinian tradition.

Stanley Edgar Hyman, a literary scholar and critic, deserves a high place in Darwin bibliography.[128] *The tangled bank: Darwin, Marx,*

Fraser and Freud, a volume evolution students should not permit themselves to neglect, discusses the Darwinian writings as literature.

Darwin demands evaluation as literature before the hidden facets of his character and personality can be understood. Repetition of unexamined words has shriveled Darwin's spirit and imprisoned his mind. The Darwinian impact has been impoverished by an incredible literalness and a strange lack of empathy. Hyman is neither deficient in breadth nor perceptiveness, but the scope of the Darwinian impact still remains too narrowly conceived; it was a shattering event of tragic proportions.

The Darwin writings in their entirety stand in the tragic tradition. Ambivalence there is, and Darwin oscillates as his mood and mind alter, but there is a clear development. Darwin reported tragedy in nature and whatever "the Victorian compromise", Darwin himself could not accept it. Darwin's experience was unique. He communicated a new experience, a full-bodied vision, which in one sense he alone experienced. For Darwin it was an intimate, spiritual experience; for all others it was vicarious. One may quarrel with Hyman's formula: struggle, adaptation, triumph. Darwin's triumphs are temporal and vital energies are as "natural" as mechanical energies. Teleology was muddled in Darwin's thinking, and his protracted discussions with Lyell, Gray and others reveal that finally he held no such doctrine. In any case, teleological explanations in functional analysis do not necessarily imply a metaphysics of final cause. If "there is grandeur in this view of life, with its several powers", perhaps it is because, irrespective of ultimate meanings, there is hope for man, if not for mankind. If so, it is a tragic hope.

Loren Eiseley's *Darwin's century* is likewise of singular literary and scholarly merit.[129] An anthropologist who knows about fossils at first hand, Eiseley is fully at one with Darwin during the "Beagle" experience, an identification which enables every reader to share in Darwin's discoveries. The Lyell problem is handled with a detective's sagacity except that Eiseley's deductions are confined to the third edition of Lyell's *Principles* (1834), and Darwin's electrifying reactions to Lyell were the result of his reading of the fifth edition (1837).[130] A biography of Lyell, recently published, makes no use of new documentary evidence, but reveals the advantages of its authorship by an outstanding geologist, Sir Edward Bailey.[131]

Two works augment the Darwin biographical listings. Gerhard Wichler's *Charles Darwin* cannot be compared with de Beer's study. Practically half the book is pre-empted by a history of the theory of evolution. Evolutionary notions in the classical age are properly omitted, but the period from the mid-seventeenth century to the mid-nineteenth is too large a segment of time to survey in so small a compass of space. As intellectual history the attempt fails although many astute

comments are to be found on men, ideas and consequences. The portions on Darwin, natural selection and the influence of both on biological scholarship, are infinitely more successful. A considerable number of American and English works remain unnoticed, but a considerable number of German works, largely unnoted by English-speaking scholars, are used and cited.[132]

Renewed interest in Darwin has awakened interest in the members of the Darwin circle. The individual stature of Darwin's friends, associates and adversaries is not automatically established by the Darwin relationship. Nor is it always clear at what periods and for what purposes, creative or otherwise, the contacts are meaningful. St George Mivart, it seems safe to conclude, did not enjoy wide acclaim as a scientist, a teacher or as a Catholic scholar and little in his intellectual life would have assured his historical reputation. Darwin immortalized Mivart and his *Genesis of species* in the sixth edition of the *Origin*.[133] Asa Gray's impact on Darwin was precise both in time and content, but it would be doubtful to claim that Darwin owed more to Gray as a botanist than he owed to Joseph D. Hooker. Yet it is Darwin's letters to Gray, not to Hooker, which make up part of the Linnean Society *Papers* of 1858.[134] Even Alfred Russel Wallace, whose influence on Darwin was both immediate and traumatic, might well have remained a remote nineteenth-century figure in the history of science had not Darwin and the history he made altered Wallace's future.[135]

Wilma George, a respected student of genetics and geographical distribution, has resuscitated Alfred Russel Wallace. Darwin prevented oblivion from enveloping "the co-discoverer of natural selection", but Wallace deserves more than fame by association. Miss George eminently succeeds in providing him with a proper niche in the history of western thought. In *Geographical distribution of animals* (1876) Wallace outlined the shape of modern zoogeography. He was first to integrate the total extant evidence of geographical distribution without confining himself to a single class of animals or a single part of the globe. In addition, he incorporated concepts and data from contiguous disciplines, paleontology, glacial theory and the doctrine of evolution. Darwin gave Wallace universal acclaim; Wallace earned an honorable place in historical annals on his own.[136]

The perspicacious among Darwin's contemporaries sensed almost at once that the *Origin of species* signaled the end of one era and the beginning of another. Thereafter, "Darwin and after Darwin" became a temporal division in the history of thought as well as a category of analysis. The study of the life and work of Charles Darwin is of perennial import. Darwin gave to biology—and hence to the investigation of life and of human kind—its modern cast and its modern spirit, for evolutionary biology is a phrase as tautologous as Darwinian evolution.

Elaboration and qualification are the inevitable legacies of ideas. But the elaborations and qualifications of Darwinian evolution have been made in terms of Darwin and the insightful suggestions to which he attached his name. Darwin's version of evolution still continues to quicken the imagination, for the eternal quest of mankind is man. What Darwin communicated to his fellow men echoes in his mind and his heart and is built into his body. He who notes with scorn, Darwin wrote, "that the shape of his own canines, and their occasional great development in other men, are due to our early forefathers having been provided with these formidable weapons, will probably reveal, by sneering, the line of his descent".

Natural science, Sir Charles Sherrington remarks, "looks at Nature through the medium of ourselves". From the vantage point of science there is "no fundamental gap between man and Nature. . . ".[137] Distinctions between man and nature which human experience commands us to make are historical distinctions, they come later in time. Man cannot escape self-involvement. Objectivity is an acquired characteristic, an acculturated mood. Objectivity, either of the nature of things or of attitudes toward them, is not a quality inherent in observers or in the things observed. It is a quality of the observation after it has been critically examined and evaluated. It is itself a judgment. Studies of nature and of life, Marston Bates wisely observes, are "of immediate concern to all of us . . . ".[138]

No less vital are investigations of astronomy, physics and climatology. But the science of life focuses upon human existence in ways which compel human attention. If, as Erik Erikson has been at some pains to stress, historians cannot ignore the fact that all men have mothers and that childhood is a critical molding period,[139] neither can they ignore the quality and diversity of populations, animal and human. Darwin made animal behavior and ecology aspects of living history as well as aspects of the history of life. Animal behavior and ecology are examples selected at random; they might as well be biochemistry or paristology. Genetics may be partly mathematical, heredity partly chemical and geology partly physical, but they are none the less partly historical.

Darwin and Darwinism have made biologists acutely sensitive to history. The *Origin of species* is a history of the development of biological forms; the *Descent of Man* a history of the development of human life. Professional historical scholars are keenly aware of the subtleties of climate, agriculture and health. They are parts of the ecological pattern of existence. They are normally somewhat less conversant with the intricacies of cells, enzymes and heredity but biologists are eager to make them so.[140] "Man cannot reach a valid understanding of his own nature", Dobzhansky asserts, "without a knowledge of his own biological background". Indeed, it may well, be he continues, "that the study of

evolutionary biology, is the most important practical endeavor open to the human mind".[141] Dobzhansky's conviction is reinforced by the opinion of Sir Charles P. Snow, whose reputation is almost as pervasive as the revolution he describes. The future of molecular biology which, following the analysis of D.N.A. has "taught us the essential lesson about our genetic inheritance", is likely, he believes, "to effect the way in which *men think of themselves* more profoundly than any scientific advance since Darwin's—and probably more so than Darwin's".[142]

Historical-mindedness among biologists is not as surprising as its absence. Save when immured by specialist abstraction, biologists are not likely to forget the functions of relatedness, the insights of comparison and the centrality of man. N. J. Berrill cautions that "the need to know what has happened and where we are drifting is becoming steadily if not desperately more important". He is inspired by "the roaring onward sweeping confusion of events that comprise the human past", but he is inspired not only by the written record. The unwritten record, which he reconstructs with consumate skill, stimulates his pride in humanity and his amazement in its accomplishment. We are, he writes, "blessed with more real time than any other living creature and cursed with enough awareness and intelligence to measure it". Berrill does not mean that man has a greater life-span than the tortoise who may live for two centuries or the redwood of the High Sierras which may endure for three to four thousand years. He means that humans have a larger period of creative time for reflection, for human living. "We are a time-binding species and perhaps more than any other we have become a time-binding generation intent on reconstructing the past billion years and forecasting our planetary future."[143]

The human implications of biology are as impelling in the present as they have always been in the past. Food and health, like the diversity, size and quality of populations, are perennial issues sired by history and biology.[144] Between these issues and Charles Darwin, the historical links are genetic and precise. Francis Galton, Darwin's cousin, gave eugenics its name and the substance of pioneer studies. Darwin's son, Leonard, became president of the Eugenics Society and Darwin's grandson and namesake devoted anxious concern to the population explosion.[145] These problems continue to stir the energy and enthusiasm of biologists. "We men", proclaims Sir Julian Huxley, "belong to the last dominant type to be produced, and are now responsible for the future evolution of the planet. . . ".[146]

Huxley does not stand alone. Among biologists, as among scholars generally, there is a heightened sense of obligation to create a broader base for learning coupled with a growing sense of responsibility to contemporary society and the future of mankind.[147] A medley of factors and feelings combine to shape such attitudes. The splintering of

disciplines, the single-minded intensity of research has fostered robust anxieties about the trends of science and scholarship. Many share Huxley's conviction that "the absence of any unifying set of concepts . . . is . . . the world's major disease. . . ." Explorations in evolutionary biology, now likewise specialties, require intellectual coalescence since specialist knowledge "has cut itself off from any central common pool and from cross-fertilizing contacts with other currents of thought".[148]

The drive for larger meanings, while reflective of immediate considerations, is in the best Darwinian tradition. The *Origin of species* is a masterpiece of synthesis; the *Descent of Man* an integration of knowledge. Darwin was ceaselessly in pursuit of more inclusive meanings. Nor was he less reverential to specific data because of his devotion to theory, concept and hypothesis. If he was occasionally baffled by the implacable quandary that obtains between them, it was a bafflement no different from that of Dobzhansky:

> Two rival trends vie constantly for influence in science—specialization and synthesis. The former usually predominates. Scientists are specialists; a good specialist is able to master only some fraction or fragment of human knowledge. When a specialist writes, he feels the hot stares of his colleagues peering over his shoulder, ready to find and pounce upon any factual mistake or weakness of argument. This is, of course, as it should be, even though the privilege of criticism is sometimes abused. Attempts to synthesize knowledge are, however, indispensable. The need is the more keenly felt the more knowledge becomes splintered. Failure of synthesis would vindicate Albert Schweitzer's angry remark: "Our age has discovered how to divorce knowledge from thought, with the result that we have, indeed, a science which is free, but hardly any science left which reflects."[149]

Darwin historiography has produced a flock of stereotypes. The image of Darwin as a country recluse after his removal to Down in 1842 has induced us to think of him as leading an uneventful life. Actually, the contrary is true. His life was one of intense activity and excitement although his activities and excitements were not of a conventional sort. Likewise, his so-called rural retirement suggests a divorcement from public concerns, a lack of identification with the immediate welfare of mankind. This assumption is no less inaccurate. His identification with mankind erupts from virtually every page of the *Descent of Man* and the *Expression of the emotions*. It extrudes from his correspondence, published and unpublished, which reveals him a prime source of aid and encouragement to people—not alone scientists—all over the world. Down House, less of a shrine to be visited by the near-great in quest of greatness, emerges as more of a research center for Darwin himself and for those stirred by the problems he helped them to cultivate. If Darwin's

first reactions to slavery were based on his feelings—a fact as much to the credit of his character as to his mind—they were later based on intellectual conviction. But he was also interested in his village which he served and his country which he admired. He involved himself in education, in the development of scientific institutions, in vivisection and many other causes. Despite the "cult of the shawl" and his alleged neurotic exploitation of ill-health to ward off intrusions on his time, he was as naturally drawn to people as they to him. Charles Darwin was a humanist by temperament and by conviction.

George Gaylord Simpson takes a firm and consistent humanist stand. The chaos of the modern world, he affirms, "is one that only responsible human knowledge can reduce to order. For the first time in the history of life", he writes in the concluding paragraph of the *Meaning of evolution*, "man has increasing power to chose his course and to influence his own future evolution. . . . This makes rational the hope that choice may sometime lead to what is good and right for man. Responsibility for defining and for seeking that end belongs to all of us".[150] In another place, Simpson suggests that the goal of science is achievement of "a connected body of theory that might ultimately be *completely* general in the sense of applying to *all* material phenomena. . . . Biology . . . is the science that stands at the center of all sciences. It is the science most directly aimed at science's major goal and most definitive of that goal. And it is here, in the field where all the principles of all the sciences are embodied, that science can truly become unified."[151]

The *Origin of species* and the *Descent of Man* are not only great historical books; they are great books of history. Darwin was not only an historian of nature, he was an historian by the nature of his task. As a naturalist he swung his geological hammer with youthful gusto in the South American Andes. He studied historic and prehistoric barnacles. He weighed and measured the skeletal bones of ducks and bred pigeons with dogged experimental intensity. But the events in the lives of the progenitors of the rock pigeon, of the eohippus, of the common dog were past events, events of specific pasts to which he gave ideal existence by inferences from the present. He reconstructed the lives of species by giving symbolic meanings to existent forms. For him petrified bones were not without life nor were climbing plants without speech. Orchids and geological stratifications spoke to Darwin as the serried layers of Trojan culture spoke to Johann Winckelmann and the spires of Chartres spoke to Henry Adams. They spoke through the medium of imaginative reconstruction.

Like every great historian Darwin made the lifeless past a vital part of the living present. He coupled the scientific method of observation with the scientific method of ideal synthesis. He united the scientific method of physical experiment with the scientific method of logical

analysis. Varieties of species were his particular data. The writings of travelers, explorers, breeders and scientists were among his basic sources. Darwin discovered the theory of natural selection; he substantiated the theory of evolution. He created an hypothesis to explain transmutation; he documented the history of the descent of living forms. Darwin revivified a moribund segment of the remote past. But Darwin did more. He succeeded in putting the *whole* of past life into *every* aspect of *every* form of present life. In this respect Darwin has no precursor.

REFERENCES

1. Gordon W. Allport, *Becoming* (New Haven and London, 1955).
American Philosophical Society, Commemoration of the centennial of the publication of the Origin of Species *by Charles Darwin* (23 April 1959). *Proceedings*, ciii (Philadephia, 1959).
Anthropological Society of Washington, D.C., Evolution and anthropology: a centennial appraisal (Washington, D.C., 1959).
Antioch review. The Origin of Species—*100 Years Later*, xix (Yellow Springs, Ohio, 1959).
Edward A. Armstrong, *A study of bird song* (London, 1963).
Isaac Asimov, *The human brain, its capacities and functions* (Boston, 1964).
Issac Asimov, *A short history of biology* (Garden City, New York, 1964). Published for the American Museum of Natural History.
Sir Edward Bailey, *Charles Lyell* (London and Edinburgh, 1963).
Lady Nora Barlow, *The autobiography of Charles Darwin, 1802–1882* (London, 1958).
Anthony Barnett, *The human species* (Harmondsworth, Middlesex, 1961).
S. A. Barnett (editor), *A century of Darwin* (London, 1959).
Marston Bates, *The nature of natural history* (revised ed., New York, 1961).
Marston Bates, *The prevalence of people* (New York, 1955, 1962).
Jacques Barzun, *Science: the glorious entertainment* (New York, 1964).
P. R. Bell (editor), *Darwin's biological work* (Cambridge, 1959).
N. J. Berrill, *Man's emerging mind* (Greenwich, Conn., 1962).
N. J. Berrill, *You and the universe* (Greenwich, Conn., 1963).
Ludwig von Bertalanffy, *Problems of life* (New York, 1960).
John Tyler Bonner, *The ideas of biology* (New York and Evanston, 1964).
C. R. Boxer, *The golden age of Brazil, 1695–1750* (Berkeley and Los Angeles, 1962).
J. Bronowski, *The common sense of science* (London, 1951).
Norman O. Brown, *Life against death* (Middletown, Conn., 1959).
Norman Campbell, *What is science?* (London, 1921; New York, Dover Publications reprint, 1952).
C. O. Carter, *Human heredity* (Harmondsworth, Middlesex, 1962).
G. S. Carter, *A hundred years of evolution* (London, 1957).
Evelyn Cheesman, *Insects: their secret world* (New York, 1953).
Sir W. E. Le Gros Clark, *History of the primates* (Chicago and London, 1961.)
Sir W. E. Le Gros Clark, *The antecedents of man* (Edinburgh, 1961; New York and Evanston, 1963).
Edwin H. Colbert, *Evolution of the vertebrates* (New York, 1961).
Myron A. Coler, *Essays on creativity in the sciences* (New York, 1963).
George W. Corner, *The hormones in human evolution* (New York, 1963).
C. D. Darlington, *Darwin's place in history* (Oxford, 1959).
C. D. Darlington, "The origin of Darwinism", *Scientific American*, cc (May 1959) 60–66.
F. Fraser Darling, *A herd of deer* (Oxford, 1937; New York, 1941, 1956).
Sir Gavin de Beer (editor), *Charles Darwin and Alfred Russel Wallace. Evolution by Natural selection* (Cambridge, 1958).
Sir Gavin de Beer, "Further unpublished letters of Charles Darwin", *Annals of science*, xiv (1958) 83–115.
Sir Gavin de Beer, "Some unpublished letters of Charles Darwin", *Notes and records of the Royal Society of London*, xiv (1959) 12–66.
Sir Gavin de Beer, "The origin of Darwin's ideas on evolution and natural selection" *Proceedings of the Royal Society*, B, clv (1961) 321–338.

Sir Gavin de Beer, *Charles Darwin. Evolution by natural selection* (London, 1963).
Raymond A. Dart (with Dennis Craig), *Adventures with the missing link* (New York, 1961).
Charles Darwin, *The voyages of the Beagle.* Annotated and with an Introduction by Leonard Engel (Garden City, New York, 1962).
Charles Darwin, *The origin of species.* With an Introduction by Sir Julian Huxley (New York, 1958).
Charles Darwin, *The origin of species.* With an Introduction by Hampton L. Carson (New York, 1963).
Charles Darwin, *The origin of species.* A Facsimile of the First Edition with an Introduction by Ernst Mayr (Cambridge, Mass., 1964).
Darwin's *Notebooks on transmutation of species.* Edited with an Introduction and Notes by Sir Gavin de Beer. Parts i–iv, *Bulletin of the British Museum (Natural History)*, Historical Series, vol. ii, nos. 2, 3, 4, 5 (London, 1960).
Darwin's *Notebooks on transmutation of species. Addenda and corrigenda.* Edited with Notes by Sir Gavin de Beer and M. J. Rowlands. *Bulletin of the British Museum (Natural History)*, Historical Series, vol. ii, no. 6 (London, 1961).
Robert M. Stecher, "Darwin–Innes Letters: the correspondence of an evolutionist with his vicar, 1848–1884", *Annals of science*, xvii (1961) 201–258.
Darwin's *Ornithological notes.* Edited with an Introduction, Notes and Appendix by Nora Barlow. *Bulletin of the British Museum (Natural History)*, Historical Series, vol. ii, no. 17 (London, 1963).
Francis Darwin (editor), *The autobiography of Charles Darwin and selected letters* (New York, Dover Publications reprint, 1958).
Francis Darwin (editor), *The life and letters of Charles Darwin.* With a Foreword by George G. Simpson, 2 vols (reprinted New York, 1959).
Darwin library List of books received in the University Library, Cambridge, March–May 1961 (Cambridge, n.d., offset).
Theodosius Dobzhansky, *Evolution, genetics and man* (New York, 1955).
Theodosius Dobzhansky, *Mankind evolving* (New Haven and London, 1962).
Gerard De Gré, *Science as a social institution* (New York, 1955).
Thomas W. Donnelly, *The Earth sciences* (Chicago, 1963).
W. H. Dowdeswell, *The mechanism of evolution* (New York and Evanston, 1960).
Gösta Ehrensvärd, *Life: origin and development* (Chicago, 1962).
Loren Eiseley, *The immense journey* (New York, 1957).
Loren Eiseley, "Charles Darwin, Edward Blyth, and the theory of natural selection", *American Philosophical Society, Proceedings*, ciii (1959) 94–158.
Loren Eiseley, *Darwin's century* (Garden City, N.Y., 1961).
Loren Eiseley, *The firmament of time* (New York, 1962).
Alvar Ellëgard, *Darwin and the general reader* (Gothenburg studies in English, viii, Göteborg, 1958).
Sir Ronald A. Fisher, *The genetical theory of natural selection* (New York, Dover Publications, reprint of 2nd ed., 1958).
Robert E. Fitch, "Charles Darwin: science and the saintly sentiments", *Columbia University Forum*, ii (1959) 7–12.
Philipp Frank, *Philosophy of science* (Englewood Cliffs, New Jersey, 1957).
Francis Galton, *Hereditary genius.* With an Introduction by C. D. Darlington (Cleveland and New York, 1962).
Wilma George, *Biologist philosopher. A study of the life and writings of Alfred Russel Wallace* (London, Toronto and New York, 1964).
Brewster Ghiselin (editor), *The creative process* (New York, 1955).
Bentley Glass, Owsei Temkin, and William Strauss, Jr. (editors), *Forerunners of Darwin: 1745–1859* (Baltimore, 1959).
Wilhelm Goetch, *The ants* (Ann Arbor, Mich., 1957).
Handlist of Darwin papers at the University Library Cambridge (Cambridge, 1960).
Garrett Hardin, *Nature and Man's fate* (New York and Toronto, 1959).
Gertrude Himmelfarb, *Darwin and the Darwinian revolution* (Garden City, N.Y., 1962).
Sir Julian Huxley, *New bottles for new wine* (New York, 1957).
Sir Julian Huxley, "The three types of evolutionary process", *Nature*, clxxx (7 September 1957) 454–455.
Sir Julian Huxley "The emergence of Darwinism", *Journal of the Linnean Society*, xliv (1958) 1–14.
Sir Julian Huxley (assisted by Thomas Fisher), *The struggle for life. The living thoughts of Darwin* (Greenwich, Conn., 1963).
Thomas H. Huxley, *Man's place in nature.* Introduction by Ashley Montagu (Ann Arbor, 1959).

Stanley Edgar Hyman, *The Tangled Bank. Darwin, Marx, Frazer and Freud as imaginative writers* (New York, 1962).
Alan Isaacs, *Introducing science* (Harmondsworth, Middlesex, 1963).
Abram Kardiner and Edward Preble, *They studied Man* (New York, 1963).
L. Kellner, *Alexander von Humboldt* (London, 1963).
H. B. D. Kettlewell, "Darwin's missing evidence", *Scientific American*, cc (March 1959) 48–53.
William S. Knickerbocker (editor), *Classics of modern science* (Boston, 1962).
G. H. R. von Koeningswald, *The evolution of Man* (Ann Arbor, Mich., 1962).
David Lack, *Darwin's finches* (Cambridge, 1947; New York, 1961).
L. S. B. Leakey, *Adam's ancestors* (London, 1934, 1953; New York and Evanston, 1960).
Victor F. Lenzer, *Procedures of empirical science. International encyclopedia of unified science*, i, no. 5 (London and Chicago, n.d.).
Ludwig Lewinsohn, *Animals, men and myths* (Greenwich, Conn., 1964).
Wyndham Lewis, *Time and western Man* (Boston, 1957).
Konrad Z. Lorenz, *King Solomon's ring*. Foreword by Julian Huxley (New York, 1962).
Thomas Robert Malthus, *Population: the first essay*. With a Foreword by Kenneth E. Boulding (Ann Arbor, 1959).
Floyd W. Matson, *The broken image: Man, science and society* (New York, 1964).
Ernst Mayr, "Isolation as an evolutionary factor", *Proceedings of the American Philosophical Society*, ciii (1959) 221–230.
Ernst Mayr, "Agassiz, Darwin, and evolution", *Harvard Library bulletin*, xiii (1959) 165–194.
Margaret Mead, *Continuities in cultural evolution* (New Haven and London, 1964).
E. H. Mercer, *Cells: their structure and function* (Garden City, New York, 1962).
Guy S. Metraux and François Crouzet (editors), *The evolution of science. Readings from the history of mankind* (New York, 1963).
Milton Millhauser, *Just before Darwin, Robert Chambers and vestiges* (Middletown, Conn., 1959).
Gairdner B. Moment, *Frontiers of biology* (Boston, 1962).
Ashley Montagu, *The biosocial nature of Man* (New York, 1956).
Ashley Montagu, *Man: his first million years* (New York, revised ed., 1962).
Lewis Henry Morgan, *Ancient society*. Edited by Elanor Burke Leacock with an introduction and annotations (Cleveland and New York, 1963).
William Paley, *Natural theology selections*. Edited, with an introduction, by Frederick Ferré (New York, 1963).
Morse Peckham (editor), *The* Origin of Species *by Charles Darwin. A variorum text* (Philadelphia, 1959).
Karl R. Popper, *The logic of scientific discovery* (New York, 1961).
Adolf Portmann, *New paths in biology* (New York, Evanston and London, 1964).
de Solla D. J. Price, *Little science, big science* (New York and London, 1963).
Magnus Pyke, *The boundaries of science* (Harmondsworth, Middlesex, 1961).
Jay Ellis Ransom, *Fossils in America* (New York, Evanston and London, 1964).
Hans Reichenbach, *The rise of scientific philosophy* (Berkeley and Los Angeles, 1963).
F. H. T. Rhodes, *The evolution of life* (Harmondsworth, Middlesex, 1962).
Philip C. Ritterbush, *Overtures to biology. The speculations of eighteenth century naturalists* (New Haven and London, 1964).
Anne Roe and George G. Simpson (editors), *Behaviour and evolution* (New Haven, 1958).
Arthur Rook (editor), *The origins and growth of biology* (Harmondsworth, Middlesex, 1964).
John Paul Scott, *Animal behavior* (Garden City, New York, 1963).
Sir Charles Sherrington, *Man of his nature* (New York, reprinted, 1964).
George G. Simpson, *Horses* (Garden City, New York, 1961).
George G. Simpson, *Life of the past* (New Haven, 1961).
George G. Simpson, *This view of life* (New York, 1964).
George G. Simpson, *The meaning of evolution* (New Haven, 1964).
Edmund W. Sinnott, *Matter, mind and Man. The biology of human nature* (New York, 1962).
John Maynard Smith, *The theory of evolution* (Harmondsworth, Middlesex, 1958).
Sydney Smith, "The origin of 'The Origin' ", *The advancement of science*, no. 64 (March 1960) 391–401.
Sir Charles P. Snow, *The two cultures: and a second look* (Cambridge, 1959, 1964; New York, 1964).

Robert C. Stauffer, "Ecology in the long manuscript version of Darwin's *Origin of Species* and Linnaeus' *Oeconomy of Nature*", *Proceedings of the American Philosophical Society*, civ (1960) 235–241.
Charles H. Southwick (editor), *Primate social behavior* (Princeton, n.d.).
William Graham Sumner, *Social Darwinism:* selected essays of William Graham Sumner. Edited by Stow Persons (Englewood Cliffs, N.J., 1963).
William Graham Sumner, *An essay of commentary and selections* by Maurice R. Davie (New York, n.d.).
William Graham Sumner, *Folkways* (New York, 1959).
F. Sherwood Taylor, *A short history of science and scientific thought. With readings from the great scientists from the Babylonians through Einstein* (London, 1963).
Sol Tax (editor), *Evolution after Darwin*, 3 vols. (Chicago, 1960), i, *The evolution of life*; ii, *The evolution of Man*; iii (with Charles Callender), *Issues in evolution.*
Edwin Way Teale, *Adventures in nature* (New York, 1959).
Sir Edward B. Tylor, *Anthropology.* Abridged with a Foreword by Leslie A. White (Ann Arbor, Mich., 1960).
A. Hyatt Verrill, *The strange story of our Earth* (Greenwich, Conn., 1962).
Victorian studies, Darwin anniversary issue, iii (Bloomington, Indiana, 1959).
C. H. Waddington, *How animals develop* (New York, reprinted 1962).
Marshall Walker, *The nature of scientific thought* (Englewood Cliffs, N.J., 1963).
Victor E. Weisskopf, *Knowledge and wonder* (Garden City, New York, 1963).
C. F. von Weizäcker, *The history of nature* (Chicago and London, 1949).
Lancelot L. Whyte, *The next development of Man* (New York, 1950).
Gerhard Wichler, *Charles Darwin* (Oxford, London, New York and Paris, 1961).
W. P. D. Wightman, *The growth of scientific ideas* (New Haven and London, 2nd printing, 1964).
Gordon Wolstenholme (editor), *Man and his future* (Boston and Toronto, 1963).
Conway Zirkle, *Evolution, Marxian biology, and the social scene* (Philadelphia, 1959).

2. Darlington, *Darwin's place in history*, and Himmelfarb, *Darwin and the Darwinian revolution*, are two outstanding examples. See also Robert E. Fitch, "Charles Darwin: science and the saintly sentiments", *Columbia University Forum*, ii (1959) 7–12.
3. Himmelfarb, 8.
4. J. Z. Young, "The Darwin centenary", *New statesman* (15 May 1958), 337.
5. Price, *Little science, big science*, 81; also 73.
6. Geoffrey West, *Charles Darwin. The fragmentary man* (London, 1937) is a significant exception.
7. Nora Barlow's splendid edition of *The autobiography of Charles Darwin* (London, 1958) is also an outcome of the Collection.
8. See *Handlist of Darwin papers* and *Darwin library*.
9. Francis Darwin (ed.), *The life and letters of Charles Darwin*, 3 vols. (London, 1887), ii, 16–17.
10. Darlington, *Darwin's place in history*, 35–36; Barlow, *Autobiography*, 167 *ff.* Butler's annotated copy of the *Origin* is in the Library of St John's College, Cambridge.
11. Darwin was not seeking ultimate answers as Himmelfarb, 155–166, insists.
12. See Barlow's fully documented edition of Darwin's *Ornithological notes* and her forthcoming collection of J. S. Henslow's letters.
13. "No one should attempt a biography of Darwin until the critical analysis of the notebook material has been completed" (Ernst Mayr, *Science*, cxxxiv (1 September 1961) 607). The same should be said for almost every category of the Darwin Collection.
14. De Beer's critical editions are listed in n. 1. Attention should be called to the work of Paul H. Barrett, "A transcription of Darwin's first notebook on 'Transmutation of Species'", *Bulletin of the Museum of Comparative Zoology (Harvard)*, cxxii (1960) 249–296.
15. De Beer, *Notebook*, ii, 77.
16. Smith, "Origin of 'The Origin'".
17. See n. 52.
18. Smith, 398.
19. Lovejoy, "The argument for organic evolution before the 'Origin of Species', 1830–1858", *Forerunners*, 356 *ff.*
20. Smith, "Origin of 'The Origin'", 393.
21. Millhauser, *Just before Darwin*; W. Frank Blair, "Ecology and evolution", *Antioch review*, 47–55.
22. *Darwin library*; Smith, "Origin of 'The Origin'", 399; De Beer, Notebook, I and II.
23. Eiseley, "Charles Darwin, Edward Blyth, and the theory of natural selection".

24. Smith, "Origin of 'The Origin'", 399.
25. The Blyth Correspondence at Cambridge has not yet been catalogued. Some items are listed in *Handlist of Darwin papers*; the recent accessions from the British Museum (Natural History) are in alphabetical order.
26. Smith, "Origin of 'The Origin'", 399.
27. Smith, 400.
28. *Darwin library*.
29. Bentley Glass, "Maupertius, pioneer of genetics and evolution", *Forerunners*, 51–83; Charles C. Gillipsie, "Lamarck and Darwin in the history of science", *Forerunners*, 265–291.
30. Simpson (ed.), *Life and letters of Charles Darwin*, i, p. vii; Ritterbush, *Overtures to biology*.
31. I. M. Lerner, "The concept of natural selection: a centennial view", *American Philosophical Society, Centennial*, 173.
32. Waddington, "Theories of evolution", *Century of Darwin*, 4, 5.
33. Henry F. Osborn, *From the Greeks to Darwin. An outline of the evolution idea* (New York and London, 1924); Waddington, "Theories of evolution", *Century of Darwin*, 1; Ellegard, *Darwin and the general reader*, which summarizes without synthesis some of the data requisite for understanding; John C. Greene, *The death of Adam. Evolution and its impact on western thought* (Ames, Iowa, 1959).
34. Smith, "Origin of 'The Origin'", 392.
35. Robert C. Stauffer, "On the *Origin of Species:* an unpublished version", *Science*, cxxx (27 November 1959) 1449–1452.
36. De Beer, *Darwin*; West, *Darwin*.
37. Darlington, *Darwin's place in history*.
38. Simpson, *This view of life*, 9, 8. Italics in original.
39. Darlington, 14–15. Italics in original.
40. Darlington, 62.
41. Donald Michie, "The third stage of genetics", *Century of Darwin*, 56–84.
42. Charles Darwin, *The variation of animals and plants under domestication*, 2 vols. (London, 1868), ii, 92.
43. Quoted in Darlington, 18. These editions are given in Darlington; they require collation with the editions in Darwin's library and analysis in terms of his annotations.
44. Darlington, 60. See also 31, 67.
45. Darlington, 61–62.
46. Simpson, *This view of life*, 46.
47. Himmelfarb, *Darwin and the Darwinian revolution*.
48. Snow, *Two cultures*; Barzun, *Science*; Marson, *Broken image*; Frank, *Philosophy of science*; Walker, *Nature of scientific thought*; Bronowski, *Common sense of science*; Von Weisacker, *History of nature*; Reichenbach, *Rise of scientific philosophy*; Campbell, *What is science?*
49. Himmelfarb, 319.
50. The documentation reveals that the manuscript materials were not sufficiently used to justify the assertion that the study is based on the data of the Cambridge Collection.
51. Himmelfarb, 59.
52. Himmelfarb, 59; above n. 17.
53. Himmelfarb, 419.
54. Darwin, *Life and letters*, iii, 25, in which Darwin states that a belief in natural selection must rest upon general considerations:
    (1) On its being a *vera causa*, from the struggle for existence; and the certain geological fact that species do somehow change.
    (2) From the analogy of change under domestication by man's selection.
    (3) And chiefly from this view connecting under an intelligible point of view a host of facts.
55. Mayr, *Scientific American*, cci (November 1959) 209–221. Citations following are from an uncut mimeographed version, p. 5.
56. Mayr thinks highly of the Himmelfarb volume in its biographical aspects, a view the present writer rejects. See Philip Appleman, *Victorian studies*, 125; Mayr, *Scientific American*, 8.
57. De Beer, *Darwin*, p. vi.
58. In addition, Bates, *Prevalence of people*. Gamov's two books were republished by Mentor Books, New York, 1948 and 1953 respectively.
59. Himmelfarb, 314.
60. Darwin Papers, Black Box, B c. 40. i.

61. Simpson, *This view of life*, 153.
62. Darwin Papers, Black Box, B e. 40. i.
63. Simpson, *Horses*, p. xxxii.
64. Simpson, *Horses*, 269.
65. Himmelfarb, 356; Chicago Centennial, *Issues in evolution*, 167–174.
66. Le Gros Clark, *History of the primates*, 179. See also *Antecedents of Man*.
67. Leakey, *Adam's ancestors*; Dart, *Adventures with the missing link*.
68. Above n. 1 for a representative listing of Simpson's works.
69. Charles Darwin, *The descent of man and selection in relation to sex*, 2 vols. (London, 1871) ii, 405.
70. *Descent of Man*, ii, 404.
71. Mayr, *Scientific American*, 4; Dobzhansky, "Genetics and the destiny of man", *Antioch review*, 59.
72. Julian Huxley, A. C. Hardy, and E. B. Ford (eds.), *Evolution as process* (London, 1954), 91; Fisher, *Genetical theory of natural selection*.
73. Lerner, *American Philosophical Association, Centennial*, 181.
74. Mayr, *Scientific American*, 5.
75. Simpson, *Life of the past*, 148.
76. Mayr (ed.), *Origin of species*. C. D. Darlington's edition of the first edition is also available in the Thinker's Library, *On the origin of species* (London, 1950).
77. De Beer, *Darwin and Wallace*.
78. Chicago Centennial, "The emergence of Darwinism", *Evolution of life*, 1–21; "The evolutionary vision", *Issues in evolution*, 41–65. See above n. 1 for listing.
79. Simpson, above n. 1. Marston Bates and Philip S. Humphrey, *The Darwin reader* (New York, 1956).
80. Montagu, Huxley, above n. 1.
81. Darwin, *Beagle*, above n. 1. The Natural History Library, devoted particularly to the life and earth sciences, makes paperbound books of "enduring interest" available. A board at the American Museum of Natural History "guides" the venture.
82. Peckham, *Variorum text*. "Darwinism and Darwinisticism", *Victorian studies*, 21 n.
83. Malthus, Paley, above n. 1.
84. Galton, *Hereditary genius*. Darlington's comments are illuminating.
85. Above n. 1.
86. Above n. 1. See also, Asimov, *History of biology*.
87. Rhodes, above n. 1; Smith, ii.
88. Verrill, above n. 1; Bonner, vii; Weiskopf, *Knowledge and wonder*, 41 ff.; Weizäcker, *History of nature*, 1–59.
89. *Century of Darwin*.
90. Waddington, "Theories of evolution", *Century of Darwin*, 5.
91. Dobzhansky, "Species after Darwin", *Century of Darwin*, 9–18; quotation at p. 20.
92. Michie, "The thirth stage in genetics", *Century of Darwin*, 56–83. Quotation at p. 69.
93. A. S. Romer, "Darwin and the fossil record", 130–152; De Beer, "Darwin and embryology", 153–172; Le Gros Clark, "The study of man's descent", 173–205. See also S. A. Barnett, "The 'Expression of the Emotions' ", 206–230; J. M. Smith, "Sexual selection", 231–244.
94. Bell, *Darwin's biological work*, p. xii.
95. Bell, "The movement of plants in response to light", 1–49.
96. J. B. S. Haldane, "Natural selection", 150–206, esp. 103–104; 141–149.
97. Marler, "Developments in the study of animal communication", 150–206.
98. Marler, 206. Edward A. Armstrong, *A study of bird song* (London, 1963) is a notable study; Lorenz, *King Solomon's ring* is a famous one.
99. H. L. K. Whitehouse, "Cross- and self fertilization in plants", 207–261. Quotation at 258.
100. J. S. Wilkie, "Buffon, Lamarck and Darwin: the originality of Darwin's theory of evolution", 262–307. J. Challinor, "Paleontology and evolution", 50–100 is a pertinent essay and confers additional lustre on this distinguished volume.
101. Dobzhansky, *Antioch review*, esp. 59; above n. 71. Also included in this issue: H. K. Girvitz on philosophical implications, 9–19; R. E. Fitch on Darwinism and Christianity, 20–32; George E. Simpson on Darwin and 'Social Darwinism', 33–45.
102. Peckham, *Victorian studies*; above n. 82. Other essays in this issue are: Bert James Loewenberg, "The mosaic of Darwinian thought", 3–18; John Passmore, "Darwin's impact on British metaphysics", 41–54; Irving Goldman, "Evolution and anthropology", 55–75; Cyril Bibby, "Huxley and the reception of the 'Origin' ", 76–86; Edward Lurie, "Louis Agassiz and the idea of evolution", 87–108. Special attention should be called to the review essay "Evolution: two books and some

Darwin marginalia", by Sydney Smith, 109–114 and Philip Appleman, "The logic of evolution: some reconsiderations", 115–125.

103. Haldane, *Darwin's biological work*, 104.
104. Mayr, "Darwin and the evolutionary theory", *Evolution and anthropology*, 2.
105. Among the papers reprinted are: T. D. Stewart, "The effect of Darwin's theory of evolution on physical anthropology"; J. S. Weiner, "Physical anthropology: an appraisal"; A. Irving Hallowell, "Behavioral evolution and the emergence of the self"; Joseph H. Greenberg, "Language and evolution"; Robert J. Braidwood, "Archaeology and the evolutionary theory"; William G. Haag, "The status of evolutionary theory in American history"; George P. Murdock, "Evolution in social organization"; Leslie A. White, "The concept of evolution in cultural anthropology"; Clyde Kluckhohn, "The role of evolutionary thought in anthropology".
106. Chicago Centennial, *Evolution after Darwin*. There is additional material on arrangements and festivities.
107. Huxley, "The emergence of Darwinism", *The evolution of life*, 1–21; Shapley, "On the evidences of inorganic evolution", 23–38; Gaffron, "The origin of life", 39–84; Evans, Jr., "Viruses and evolution", 85–93; Rensch, "The laws of evolution", 95–116; Simpson, "The history of life", 117–180.
108. Ford, "Evolution in progress", 181–196; Stebbins, "The comparative evolution of genetic systems", 197–226.
109. Stebbins, 198–199.
110. Axelrod, "The evolution of flowering plants", 227–305; quotation at p. 227.
111. Quotation at p. 227.
112. Emerson, "The evolution of adaptation in population systems", 307–348; quotations at 310, 309. See also 319 *ff.*
113. Mayr, "The emergence of evolutionary novelties", 349–380.
114. St George J. Mivart, *Genesis of species* (London, 1871). Darwin's annotated copy is in the Darwin Collection, University Library, Cambridge. Himmelfarb, 318–319, employs this outmoded argument. For a devastating comment, see Mayr, *Scientific American*, 6.
115. For example, Everett C. Olson, "Morphology, paleontology, and evolution", 524.
116. Waddington, "Evolutionary adaptation", 381–402; quotation at p. 389.
117. Waddington, "Evolutionary adaptation", 386. "Natural selection, which was at first considered as though it were an hypothesis that was in need of experimental or observational confirmation, turns out on closer inspection to be a tautology, a statement of an inevitable although previously unrecognized relation. It states that the fittest individuals in a population (defined as those who leave most offspring) will leave most offspring. Once the statement is made, its truth is apparent" (p. 385; see also 387).
118. Dobzhansky, "Evolution and environment", 403–428; quotation at p. 404.
119. Dobzhansky, "Evolution and environment", 405, 407. Sewall Wright presents an analysis of "Physiological genetics ecology of populations and natural selection" (429–475) "to consider the mathematical framework of the theory of evolution at a succession of levels of complexity" (429).
120. Nicholson, "The role of population dynamics in natural selection", 477–521.
121. Olson, "Morphology, paleontology, and evolution", 524.
122. Ibid., 530, 543. Von Bertalanffy, *Problems of life*, 89.
123. Prosser, "Comparative physiology in relation to evolutionary theory", 569–594. Quotation at p. 592.
124. Tinbergen, "Behavior, systematics, and natural selection", 595–613. For other studies in this and related fields, see above n. 98; Scott, *Animal behavior*; Darling, *A herd of red deer*; Goetsch, *Ants*; Cheesman, *Insects*.
125. Bates, "Ecology and evolution", 547–568. G. F. Gause, Scientific Director of the Institute of Antibiotics of the Academy of Medical Science, Moscow, contributes the final essay, "Darwinism, microbiology, and cancer", 615–629.
126. *The evolution of Man* is composed of twenty-two papers, of which twelve are by anthropologists, archeologists and ethnologists. They are as follows: Alfred L. Kroeber, "Evolution, history, and culture"; L. S. B. Leakey, "The origins of the genus Homo"; S. L. Washburn and F. Clark Howell, "Human evolution and culture"; Cesare Emiliana, "Dating human evolution"; Edgar Anderson, "The evolution of domestication"; Stuart Piggott, "Prehistory and evolutionary theory"; François Henri Bordes, "Evolution in the paleolithic cultures"; Gordon R. Willey, "Historical patterns and evolution in native New World cultures"; Robert J. Braidwood, "Levels in prehistory: a model for consideration of the evidence"; Robert M. Adams, "The evolutionary process in early civilizations";

Julian H. Steward, "Evolutionary principles and social types"; H. W. Magoun, "Evolutionary concepts of brain function following Darwin and Spencer"; Alexander von Muratt, "A decisive step in evolution: saltatory conduction"; W. H. Gantt, "Pavlov and Darwin"; Lester A. White, "Four stages in the evolution of mind"; R. W. Gerard, "Becoming: the residue of change"; Ernest R. Hilgard, "Psychology after Darwin"; Macdonald Critchley, "The evolution of Man's capacity for language"; A. Irving Hallowell, "Self, society and culture in phylogenetic perspective".

127. *Issues in evolution*, p. v, describes the method.
128. Hyman, *Tangled bank*; Bert James Loewenberg, "Darwin and the tragic vision", *American quarterly*, xiv (1962) 618–622.
129. Eiseley, *Darwin's century*.
130. Sydney Smith, *Victorian studies*.
131. Bailey, *Lyell*.
132. Wichler, *Darwin*; De Beer, above n. 36.
133. Above n. 114; Jacob W. Gruber, *A conscience in conflict. The life of St George Jackson Mivart* (New York, 1960).
134. Balanced judgment clearly awaits full assessment of the Darwin materials at Cambridge. Darwin was influenced by many men at different times with varied but cumulative results. Even the published correspondence and the documentation in his books are sufficient to induce caution. It would be hazardous to insist for instance that J. S. Henslow was of greater importance than Humboldt without a clear definition of criteria which can only be based on the nature and process of Darwin's growth. Most studies of lives who shared in Darwin's development begin and remain *in medias res*.
135. Bailey, *Lyell*; Dupree, *Gray*; Kellner, *Humboldt*; Bibby, *Victorian studies*.
136. George, *Wallace*.
137. Sherrington, *Man on his nature*, 250.
138. Bates, *Natural history*, 3.
139. Erik. H. Erikson, *Childhood and society* (New York, 1963).
140. Among many outstanding examples, see Corner, *Hormones in human reproduction*; Mercer, *Cells*.
141. Dobzhansky, *Evolution, genetics, and Man*, p. vii.
142. Snow, *Two cultures*, 69, 70. Italics in original.
143. Berrill, *Man's emerging mind*, 21, 15, 120; Portmann, *New paths in biology*; Wolstenholme, *Man and his future*; Price, *Little science, big science*; Snow, *Two cultures*; Huxley, *New bottles for new wine*.
144. See references in preceeding note; Barnett, *Human species*, 1–7 and esp. parts ii and iii; Bates, *Prevalence of people*.
145. C. G. Darwin, *Evolution of Man*, 463–473; Galton, *Heredity*; Leonard Darwin, *What is eugenics?* (London, 1928, 1929). Margaret Keynes, *Leonard Darwin 1850–1943* (Cambridge, 1943).
146. Wolstenholme, *Man and his future*, 1; Huxley, *New bottles for new wine*, 168–212.
147. Huxley, *New bottles for new wine*, 95.
148. Huxley, *New bottles for new wine*, 96–97, 95; Dobzhansky, *Evolution, genetics, and Man*, vii–ix; Weizäcker, *History of nature*, 1.
149. Dobzhansky, *Mankind evolving*, pp. xi, xii; Weizäcker, *History of nature*, 11.
150. Simpson, *Meaning of evolution*, 348.
151. Simpson, *This view of life*, 107. Italics in original. Dobzhansky, *Evolution, genetics, and Man*, p. vii.