Haeckel devoted much of his energy to the popularization of his ideas and would have been delighted with this advocacy of his central evolutionary concept.

While Haeckel's ideas are reaching countless millions of parents, few biologists outside of ichthyology and evolutionary biology have ever heard of Berg. His major study, *Nomogenesis*, probably has had little or no influence on the development of evolutionary thought and is almost unknown today. Berg suffered from the disadvantage of publishing his ideas after Haeckel and just before the first major synthesis, in the late 1920's, of the contributions of genetics to evolutionary theory. Many of the problems raised by Berg were solved by genetics or vanished as real problems in the light of newly gained knowledge of hereditary mechanisms.

Yet both authors focused on the same evolutionary problems, used the same type of factual evidence and lacked or ignored other, similar information, used the same approaches in their analyses, and reached the same general sort of conclusions. Their entire approach and their conclusions are of great importance to any biologist interested in evolutionary theory, not because of their correctness, but quite the contrary, because of their incorrectness. These books provide an excellent example of the myriad of pitfalls awaiting evolutionary biologists. It was my experience while reading both works that these many problems became far clearer than from the reading of many excellent recent treatments of evolutionary theory. Berg's *Nomogenesis* is the better book in this respect for most readers of *Science* because it is the more recent, benefiting from 50 years of biological research that was not available to Haeckel, because it is shorter and better organized, and because it is available in English.

Both Haeckel and Berg considered evolutionary mechanisms from the viewpoint of comparative morphology and embryology and with a broad training in systematics. Both workers had a wide and detailed knowledge of animal and plant groups. Neither had any deep knowledge of or interest in functional morphology (physiology) or the ecological relationships between organisms and their environment beyond the obvious and broadest concepts. And most important, neither had available or took advantage of post-1900 knowledge of hereditary mechanisms. (In fairness to Berg, it must be noted that the full implications of genetics for evolutionary theory were not appreciated until a decade after the publication of the Russian edition of his book.) Consequently, for both Haeckel and Berg the result of evolutionary mechanisms is a pattern of extreme order that could be seen throughout the spectrum of plant and animal groups. No indications of chance or random mechanisms were apparent to them, nor were they aware of any processes that would introduce chance into evolutionary mechanisms; both authors rejected chance-based evolutionary mechanisms emphatically and completely from their theory. (It should be mentioned that some modern evolutionary biologists still have difficulty in accepting chance-based evolutionary mechanisms in spite of the overwhelming evidence supporting them.) Because the biotic world appeared to be extremely ordered, the evolutionary mechanisms producing it had to be ordered mechanisms or a set of scientific laws in the classical sense. Haeckel outlines a set of "Ontogenetische Thesen" (pp. 206–10)—including his most famous one (No. 41), "Die Ontogenesis ist die kurze und schnelle Recapitulation der Phylogenesis. . . ." (p. 210)—and a set of "Phylogenetische Thesen" (pp. 256–59). The very title of Berg's book implies mechanisms in accordance with law, and in his concluding chapter Berg stresses and restresses this orderliness.

With the conviction that evolution proceeds according to a set of fixed laws, and with their extensive knowledge of embryology, it must have been an exceedingly simple step for both Haeckel and Berg to consider ontogenetical development and evolutionary development as two closely related expressions of the same general time-related biological mechanism. Hence clues to evolutionary mechanisms could be obtained from study of ontogenetical mechanisms, many of which follow highly exact and regulated laws.

Unfortunately, evolutionary development and ontogenetical development are separate and distinct time-related biological processes which have an extremely complex relationship to one another that precludes a simple understanding of evolutionary mechanisms and sequences through study of ontogenetical mechanisms. Evolution does not follow a set of ordered laws as expressed by Haeckel and Berg, and chanced-based mechanisms are very important; hence these volumes cannot be recommended as a source of accepted evolutionary ideas. Yet they are books that should be carefully studied against the background of modern evolutionary theory as a means of seeing old, important, and still unsolved evolutionary problems from a viewpoint quite different from the now-orthodox synthetic theory; I recommend both books very strongly on these grounds. The availability of Berg's *Nomogenesis* and pertinent parts of Haeckel's *Generelle Morphologie* as reprint volumes is of great value to all evolutionary biologists. Unfortunately, Haeckel's ideas are still inaccessible to most American biologists; I am unaware of any English edition of his *Generelle Morphologie*. In view of the widespread influence of Haeckel's evolutionary ideas, an English edition of his major work would be most valuable to evolutionary biologists.

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The Fruits of Travel

William Bartram: Botanical and Zoological Drawings, 1756–1788. JOSEPH EWAN, Ed. American Philosophical Society, Philadelphia, 1968. xiv + 180 pp., illus. $35. Memoirs of the American Philosophical Society, vol. 74.

The illustrations in this book are so striking that they tend to obscure the fact that it is not a mere picture book but a scholarly contribution to the history of American natural history.

William Bartram (1739–1823) was the son and traveling companion of our best-known Colonial botanist, John Bartram (1699–1777). William was a failure as a farmer and was also unsuccessful as a businessman, but he developed into an influential writer and a first-class artist. His book *Travels through North and South Carolina, Georgia, East and West Florida, the Cherokee country, the extensive territories of the Moscogulges, or Creek Confederacy, and the country of the Choctaws; containing an account of the soil and natural production of those regions, together with observations on the manners of the Indians* has a title that needs little elaboration. It also tells us what Bartram's chief interests were and where he traveled and collected the specimens that are depicted in the folio

under review. Bartram's *Travels* was issued in ten editions between 1791 and 1801. It was printed in English, Dutch, German, and French, and it did its full share in establishing the romantic European attitude toward nature and toward the American Indian. The seeds that Bartram collected and his drawings of American plants and animals became European desiderata.

The drawings reproduced in this opulent volume are those that were sent by Bartram to the British botanist Dr. John Fothergill. They are of both botanical and historical importance. Twenty-three of them (there are 60 in all) are the first representations of the species they depict. In 1780, the drawings were bought by Sir Joseph Banks, and in 1827 they became the property of the Natural History Division of the British Museum. Photostats of some of the drawings have been published, but here and for the first time they are reproduced in full. Nineteen of them are in color, and even those in black and white are reproduced with all the finish of a skillful etching.

As we would expect, Bartram's interests were primarily in botany, but he also drew birds, turtles, snakes, frogs, and fish. His flowers are drawn with all the details that a botanist would need, although sometimes the accompanying notes are not as complete as we might desire. No ornithologist should have any difficulty in identifying the birds, nor should a herpetologist find it difficult to identify the snakes. It should be emphasized also that the fine details, important to systematists, in no way detract from the pictures as a whole. The frontispiece is, appropriately enough, a colored reproduction of *Franklinia alatamaha*, the flowering tree that Bartram's collection of seeds saved from extinction.

The scholarly apparatus provided by Joseph Ewan is exceptionally complete and detailed. It consists of a biographical sketch of Bartram as a naturalist and artist and an account of his travels and discoveries. Ewan has identified all the specimens depicted in the plates—to the species level in most instances and wherever it was possible. He has also traced briefly what is known of their history. Bartram's "remarks," which accompany his drawings, are reproduced. The folio ends with a bibliography of some 250 titles, an index of scientific names, and an adequate general index. *William Bartram: Botanical and Zoological Drawings, 1756–1788*, is well worth its price.

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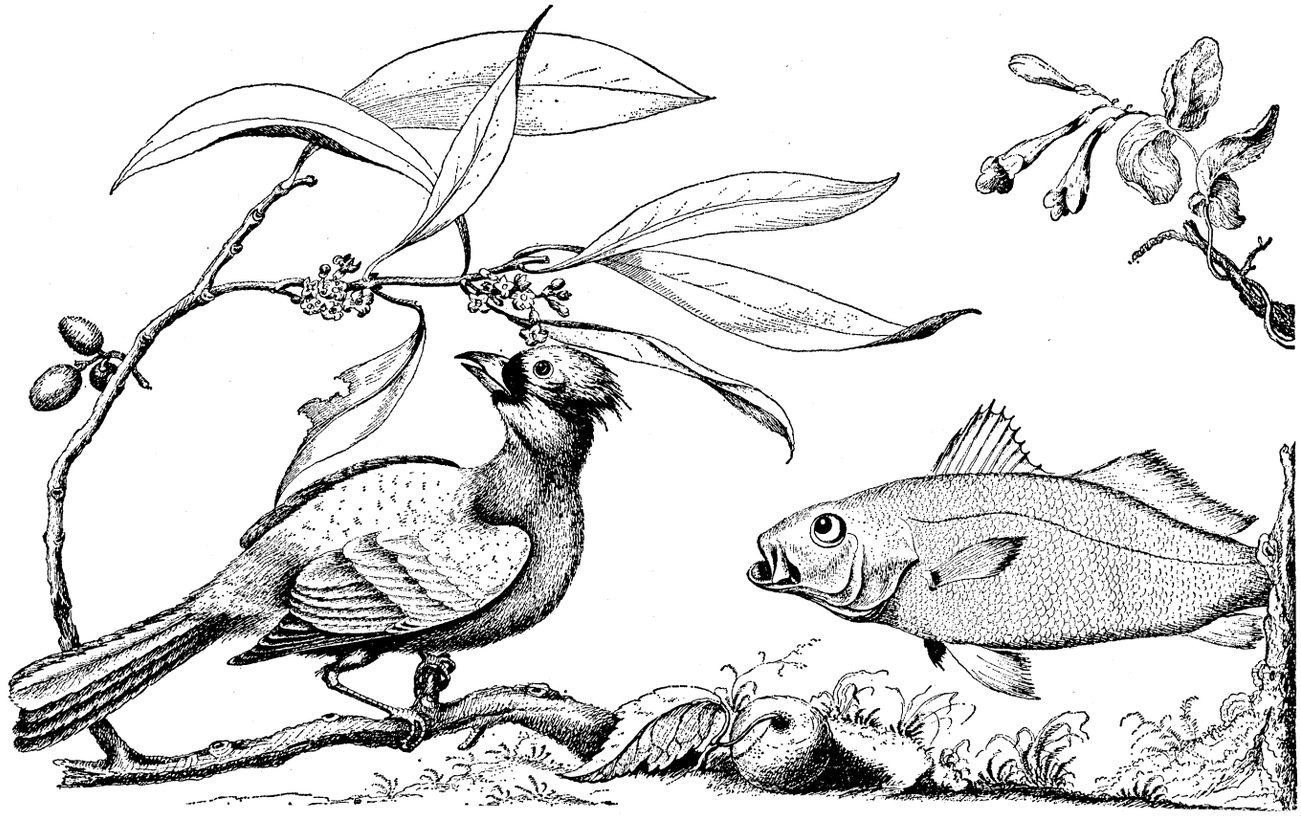
The 18th-Century Darwin

The Essential Writings of Erasmus Darwin. Chosen, edited, and with commentary by DESMOND KING-HELE. Hillary House, New York, 1969. 224 pp. + 16 plates. $7.

"[Erasmus] Darwin belongs with Leonardo da Vinci and Goethe," writes Desmond King-Hele, "in the small band of great all-rounders who excelled in both practical and theoretical work, in both literature and science." High praise indeed, but does the grandfather of Charles Darwin deserve it? Let us begin with literature. Erasmus Darwin was a popular poet in his day, one who influenced the verse of Coleridge, Wordsworth, and Keats, but the editor has not proven much more than that



Drawing dated 1772. Plants: left, *Osmanthus americanus* (L.) A. Gray, described by Bartram as "Olea Americana, Purple berr'd Bay of Cat[esby]"; center, "Wild Crab of North Carolina" (probably *Pyrus angustifolia* Ait.); upper right, the coral honeysuckle, *Lonicera sempervirens* L. The bird, *Richmondena cardinalis cardinalis*, Bartram labeled "red Sparaw or Red bird of America." No identification is offered of the fish. [From *William Bartram: Botanical and Zoological Drawings, 1756–1788*]