meat and controversy aplenty to provoke discussion here.

Though I recommend the book enthusiastically, I do want to note some shortcomings. Comparative physiology is changing in its analytical methods and conceptual framework. The outlook of Heinrich's account is primarily retrospective, rather than prospective. Therefore it sometimes misses opportunities that newer developments have provided. In spite of its taxonomic organization, it does not use phylogenetically based analyses, sometimes to the detriment of its interpretations. Endothermy in moths, for instance, is postulated to have evolved independently numerous times. We need to be assured that ancestors of different endothermic groups were in fact ectothermic and that not all currently endothermic groups had a common endothermic ancestor. If after such analysis independent evolution is demonstrated to be likely, then a variety of studies on convergent evolution and mechanism become feasible. Analytical possibilities and general interest in the results enlarge as a consequence. As another example, Heinrich argues (following Wigglesworth) that wings in all insects are homologous and evolved from the gills of a previously aquatic form. This view requires that the ancestral lineage of all winged insects was primitively terrestrial, evolved into aquatic forms whose larvae possessed the requisite gill characters, and then returned to a fully terrestrial lifestyle prior to diversification. This pterygote ancestor would presumably have been somewhat similar to a modern ephemeropteran (mayfly). Cladograms with relevant synapomorphies mapped onto them are now standard fare in comparative studies. Both these assertions, about endothermy and wing evolution, would have greatly benefited from such illustrations and the rigor they bring to evolutionary interpretations.

Though the book frequently discusses the evolution of the characters described, it is from a relentlessly adaptationist perspective, freely intuiting selective forces that presumably shaped all manner of physiological and morphological characters. Constraints on adaptation and alternative explanations are rarely considered. Assertions with these limitations have not found favor in the broader community of evolutionary biologists and tend to isolate comparative physiologists from the mainstream of evolutionary thought. Also disappointing is the scope of future directions suggested. To his credit, Heinrich does not call for more of the same and in fact lists several areas of past research that he considers unlikely to be highly productive in the future. What he does call for, however, is a focused examination of specific questions, such as the thermoregulatory role of narrow waists in wasps and patterns of hemolymph circulation during warm-up and flight. This would have been an opportunity to point to more general directions and questions in ecology and evolution that might be illuminated by research in insect thermal biology. An example of such research is the investigation of tradeoffs during thermal adaptation currently being pursued by Raymond Huey and Ary Hoffmann using fruit flies as a model experimental system. Pursuit of narrow goals is likely to perpetuate an insular outlook and to isolate comparative research, to everyone's detriment.

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The Horse Tree

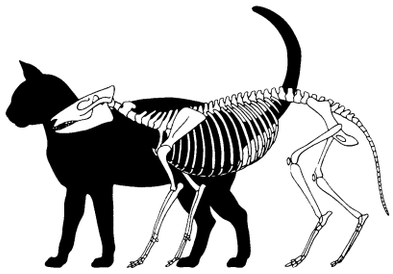
Fossil Horses. Systematics, Paleobiology, and Evolution of the Family Equidae. BRUCE J. MacFADDEN. Cambridge University Press, New York, 1992. xii, 369 pp., illus. $74.95.

As trusty mounts or rodeo broncs, pets, team animals, and sources of hair, leather, meat, and milk, horses fascinate us all. They, their still-living allies the asses, zebras, and onagers, and the recently extinct quagga are members of a single genus, *Equus*. *Equus* belongs to a formerly more diverse branch of the mammalian order Perissodactyla. The various living rhinos and tapirs also belong to the Perissodactyla but are distant horse cousins. The most familiar facts about fossil horses are that the earliest horses were about the size of fox terriers but have generally gotten larger, that horses used to have more toes on their feet, and that horses became extinct about 11,000 years ago in the New World and were reintroduced by the Spanish. However, fossil horses also tell us much about how evolution works and are excellent guide fossils for dating sedimentary rocks and for working out biogeography. Like our own genealogies, the history of horses is rich in information. Horse remains can be found as fossils as far back as about 55 million years ago, before which we know of close relatives but don't call them horses. For all but the last 10,000 years or so of this long span, various lineages of horses were primarily North American in distribution, but some spread to Eurasia and Africa by way of the Bering Land Bridge on several occasions. Horses also briefly entered South America in the Pliocene and Pleistocene, after the Panama isthmus connected the two American continents.

"'*Eohippus* and *Eohomo*' sketch done in 1876 at the Yale Peabody Museum during a meeting between Thomas Henry Huxley and O. C. Marsh." [From *Fossil Horses*; courtesy of the Yale Peabody Museum of Natural History]

If we start with the familiar still-living *Equus* and work backward to little *Eohippus* (or *Hyracotherium*) at the beginning of the Eocene, we get a long line of names: *Equus*, *Merychippus*, *Parahippus*, *Miohippus*, *Mesohippus*, *Epihippus*, *Orohippus*, *Eohippus*. This is often taken as the main line of horses, but of course that view is from the surviving twig of the horse tree toward the roots. Viewed from the roots, the horse family tree is full of equally "important" major branches, each evolving at a different and variable rate and all but one now extinct. To deal with all these branches and stages of evolution, systematists have more or less arbitrarily allocated species of the horse family to genera and other higher taxa. In addition to the single living genus *Equus* with its half-dozen living and many extinct species, there are more than 30 commonly recognized extinct horse genera, some representing lineages and some representing mere stages of evolution but all designated on the basis of such features as the number of toes, size, degree of molarization of the anterior cheek-teeth, facial fossae, crown height of the cheek-teeth, and, most of all, the crown patterns, of the cheek-teeth. Thus teeth, which are the commonest fossils, have played a very important but not exclusive role in the working out of horse phylogeny. As with beavers, microtine rodents, and certain primates, a vast pile of boring literature has built up, documenting the horse family tree in ever finer detail. Specialists mine the pile for some of the best evidence for evolution and for its mechanisms, but the work can be daunting.

In contrast, MacFadden offers a readable and even provocative status report and summary of what is known about the multibranched horse family tree over



"The smallest-known fossil horse; a skeletal reconstruction of *Hyracotherium sandrae* (from the early Eocene of Wyoming) next to a silhouette of an average-size house cat." [From *Fossil Horses*, modified from Gingerich (1989); drawing by Wendy Zomlefer]

55 million years. Besides a recitation of horse history itself, MacFadden tells us about the history of study of fossil horses, about the dangers of orthogenetic misinterpretation, about where the specimens come from and where they are studied, and about how they can be placed in a temporal and stratigraphic framework. There are chapters dealing with population dynamics, evolutionary trends (often mistaken for continuous evolution), rates of apparent change seen at various powers of resolution, and functional morphology and even some philosophical concluding comments that include remarks on what ought to be done next by researchers. These bring the subject to life. I found the various conflicting cladograms and phylograms especially fascinating, for they highlight a deeper problem: how do we best express phylogenetic concepts in words rather than diagrams? Horse research hasn't quite solved that one yet, as one can see by comparing prose rosters and written classifications with cladograms or "connect-the-dots" efforts that imply continuity like the one shown in figure 8.3. If the success of a book is to be measured by the number of pro and con comments and expletives penciled into the margins by readers, then my copy suggests that this book will be widely read and discussed by students of evolution in general. Even creationists ought to read it; they could learn something from its spirit of inquiry.

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The Life Voyage

American Lives. Looking Back at the Children of the Great Depression. JOHN A. CLAUSEN. Free Press (Macmillan), New York, 1993. xxii, 592 pp., illus. $35.

Karl Schultz was a "homely" child. In 1929, at the age of seven, he lost his father to a heart attack that came on suddenly while he and his parents were out for a walk. With the country on the verge of the Great Depression, his mother, an energetic but restless woman, managed for a year or so on life insurance. But when her divorced sister and mother came to live with them she had no alternative but to find a job (in real estate) at a time when few women worked for wages. Hardly an auspicious beginning. Still, by the time he entered high school, Karl was both studious and sociable. Secure in his abilities in science and math, he aspired to be an engineer, like his father. Karl realized that ambition—and many others. Over the next six decades, he constructed what John Clausen calls a "life well lived"—with a happy marriage to a supportive wife and, for the most part, warm relations with his own children. Moreover, various interviewers over those decades characterized the once "homely" youth not only as "intellectual" but also as a "good looking" man.

Karl Schultz exemplifies the central argument of Clausen's *American Lives*. Despite personal dislocations, despite the massive social dislocations of war and peace, of boom and bust, Karl's life has been characterized by a remarkable stability. From adolescence to early adulthood and through maturity, Karl proved himself highly dependable, intellectually invested, and confident. These three traits make up what Clausen calls "planful competence," and, Clausen argues, the degree to which they are present predicts the likelihood of a "life well lived," at least among white males.

American Lives relies on an impressive array of longitudinal data collected by the Institute of Child Welfare (now renamed the Institute of Human Development) at the University of California at Berkeley. Clausen, who became the Institute's third director in 1960, combines data on almost 300 men and women in the Berkeley and Oakland area, drawn from three longitudinal studies, two begun in 1928 on infants and their families and one begun in 1930 on adolescents and their families. In 1957, 1969, 1981, and 1990, interviewers reinterviewed respondents—and often several members of any given family (husbands and wives, mothers, children, and children's children)—probing with lengthy open-ended questions, direct observation, physical examinations, and mailed questionnaires. In 1984, Clausen himself supplemented and updated the data through life-history interviews with part of the sample. Finally, Clausen asked those study members whose cases he presents in most detail here (each of six chapters is devoted to a single individual's life history) to review and react to their histories as he presents them.

As Clausen notes, these studies were begun at a time when research design, measurement, and technology were crude by today's standards: there were, for example, no tape recorders, no computers, and few standardized psychological tests. His reflection on the imperfections of the data is refreshing; in fact, the book is made more fascinating by a historical record of research methodology and technology that parallels the history of the respondents.

Clausen's chapters alternate between the detailed case studies (three of men, three of women) and complex statistical analyses. Thus, in a display of methodological virtuosity, Clausen manages to combine longitudinal variable analysis with life histories and the analysis of these histories as narrative. This combination of techniques—with patently real people situated firmly in larger samples—produces convincing stories of a sort all too rare in a field that more often relies either on a small number of intensive life histories (whose generalizability is unknown) or on the quantitative analysis of large data sets (which often lose the humanity of the people they count). The combination of methods is impressive. But it is also occasionally awkward.

Life history and narrative analysis, more frequently practiced by anthropologists and historical biographers than by sociologists, are particularly useful for making sense of the adaptive aspects of life experience and of the cumulative relations between one stage of life and the next. Toward these ends, Clausen uses his materials effectively. But the analysis of life histories and, even more so, of narratives (of what are in effect folk autobiographies) typically also acknowledges the significance of the ways men and women make sense of their own experience. And here Clausen is less compelling. To be sure, Clausen did ask his subjects to comment on their life histories as he had written them. But these comments typically contain minor factual corrections, are bracketed in brief paragraphs, and are set apart from the main story of the life history. Thus Clausen continues to frame the life histories in his own terms—around, for example, "planful competence"—rather than those of his respondents.