Sibley and Ahlquist's rate corrections were based on a series of three-taxon relative rate tests applied to all major groups. When rate discrepancies were discovered, the authors lengthened or shortened branches in the Tapestry accordingly. Also implicit in their corrections is the notion that rate is inversely correlated with generation time. This generation-time effect is discussed in various parts of the book, and there is a table that summarizes the range of breeding ages in some groups of birds, but nowhere do Sibley and Ahlquist quantify the relationship between generation time and rates. They simply invoke generation time to explain curious differences in rates.

The small trees Sibley and Ahlquist produce from data subsets were generated by the FITCH program of J. Felsenstein's PHYLIP computer package. These trees often differ from the Tapestry and display the branch-length variability inherent when rates of evolution differ. The authors acknowledge differences between the small trees and the Tapestry, but only rarely (as in their placement of the ducks and galliforms relative to the ratites) do they opt for the more objective FITCH-tree hierarchy. Admittedly, the FITCH trees are drawn from a small subset of data; nevertheless, they provide undistorted representations of the data and tree topologies. For example, in the order Anseriformes, the Tapestry and the classification portray the Australian magpie-goose (*Anseranas*) as the sister taxon to the screamers. Yet, the FITCH trees and also an independent set of DNA-hybridization data (Madsen *et al.*, *Auk* **105**, 452 [1988]) cited by Sibley and Ahlquist indicate instead that *Anseranas* is the sister taxon of ducks and geese.

Perhaps the most graphic illustration of the issues and problems of data analysis and tree-building is to be seen in the discussion of relationships among the ratites (ostrich, emu, cassowary, rhea, and kiwi). This is the only distinct group of birds for which Sibley and Ahlquist have the data required for a rigorous phylogenetic analysis, a complete set of pairwise comparisons. The Tapestry and the classification indicate that there are two main groups, one comprising ostrich and rhea and the other kiwis, emu, and cassowaries. Data published by Sibley and Ahlquist in 1981 and the uncorrected $\Delta T_{50}H$ values presented in the current volume show that the ostrich is the sister group of all other ratites including rhea, or, more conservatively, that the branching hierarchy among ostrich, rhea, and the Australo–New Zealand species is unresolved (figures 325 and 326). Further, these data indicate that the DNA of different groups of ratites evolved at different rates (figures 18 through 24 and 325). The authors state in the text that the position of rhea is uncertain. Why then do they group it with ostrich in the Tapestry? The net result is that their classification is not always the best representation of the data. Because there are no unresolved nodes in the Tapestry to portray many uncertainties, ornithologists interested in the DNA-hybridization phylogeny will not know which phylogenetic proposals to trust.

Phylogeny and Classification of Birds is a milestone in ornithology by virtue of its herculean scope and its pioneering methodology. Several of the phylogenetic proposals are worthy of acclaim, particularly the discovery of the Australian passerine endemism. We commend Sibley and Ahlquist for trying more seriously than any predecessor to change the status quo. By insisting on a molecular approach that was in principle free of subjectivity, they set more stringent standards for phylogeny reconstruction and initially quashed authority and experience as the basis of successful systematic analysis. Their own analyses of the data, however, then fall victim to the new standards of analytical and theoretical rigor. As a result this work is a paradigm of how the idealized promise of molecular systematics of the '60s has been compromised by the predictable discoveries of its limitations.

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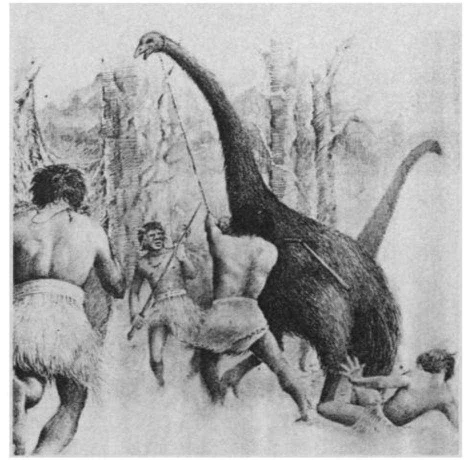
Extinct New Zealanders

Prodigious Birds. Moas and Moa-Hunting in Prehistoric New Zealand. ATHOLL ANDERSON. Cambridge University Press, New York, 1990. xviii, 238 pp., illus. $79.50.

Poking fun at ornithology, an arrogant ecologist once told me that there were three kinds of birds: large ones, small ones, and owls. After reading Atholl Anderson's book I would now add moas (Polynesian for "chicken" or "domestic fowl"). These diverse, flightless New Zealand herbivores (some apparently folivores) were as representative of New Zealand's past as sheep are of her present, and their study spans the entire spectrum of biology, from molecular evolution and systematics to plant evolution, biological anthropology, and even cryptozoology. In addition, and perhaps most important, they are the most dramatic symbol of the devastation inflicted by the Polynesians in their trek through the South Pacific; no longer will there be the image of the "noble savage" living in harmony with the environment.

Prodigious Birds is the first truly comprehensive review of the biology of these fascinating birds since the work of Archey and, especially, Oliver published in 1941 and 1949 respectively. Interestingly, the book has appeared at about the same time as a volume of the *New Zealand Journal of Ecology* (vol. 12, 1989) devoted entirely to moa biology, in which Anderson himself has a contribution. Together, these works form a new framework for the study of New Zealand's extinct giants.



"A large moa snared and speared." It has been suggested that moas were hunted in mass drives, but "moas in general were probably more wary, mobile and aggressive" than such scenarios presume. "Individual or small-group hunting of small numbers of moas at a time, indirectly by using snares or directly with the assistance of dogs, seem the most likely methods." [From *Prodigious Birds*; C. Higham, *The Maoris* (Cambridge University Press, 1981)]

Anderson's book has a pleasing introduction interweaving the discovery of the first fossil moas in the 1830s, the great public interest in them that has endured to the present, and questions about their history, particularly the idea, discredited by Anderson, that moas survived in Europeanized Fiordland.

The remainder of the book is logically divided into two major sections. Part 1 contains chapters on the discovery, systematics, origins and development, and morphology and behavior of moas and on Maori traditions bearing on them. The chapter on systematics is introduced by a historical overview and brings us up to the present. The number of moa species has ranged from a high of some 28 proposed by Oliver in the 1940s to the 13 realistically pulled from statistical analyses by Joel Cracraft in the 1970s. The chapter on origins and development takes a difficult topic and presents all sides fairly. The main question is whether moas form part of a monophyletic, flightless, ratite lineage and were drifters on floating continents or whether they arrived much later as the volant ancestral forms. Anderson astutely concludes that all we can say is that they were palaeognathous birds descended from volant ancestors.

Part 2 of the book is devoted to the history of moas at human hands and is fascinating reading for anyone regardless of field of interest. This section is complete, covering sites, hunting strategies, processing technology, and chronology and extinction. Anderson's conclusions are carefully formulated from evidence, not from hopes and fears. Moa relationships are still in doubt; mass-kill episodes probably did not occur, but individualized hunting may have been wasteful; moa-hunting began about 900 years ago and had ceased by 400 years ago, and it is unlikely that moas survived much longer than that. Anderson brings us his story from the standpoint of an anthropologist, and I would have liked more on the relationships between moas and plants, a topic covered nicely by Atkinson and Greenwood in the *New Zealand Journal of Ecology* volume. But this beautifully produced book will stand as a new landmark in the study of these bizarre New Zealand giants. It will occupy a prominent place on my bookshelves.

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Reptilians Past

Dinosaur Tracks. TONY THULBORN. Chapman and Hall, New York, 1990. xvi, 410 pp., illus. $85.

Dinosaurs, Spitfires, and Sea Dragons. CHRISTOPHER MCGOWAN. Harvard University Press, Cambridge, MA, 1991. xii, 365 pp., illus. $29.95. Revision of *The Successful Dragons: A Natural History of Extinct Reptiles* (1983).

Two prominent and productive vertebrate paleontologists here weigh in with good, readable books about very different aspects of dinosaurs and other extinct beasts. Though both books are curiously lacking in phylogenetic perspective, both are highly competent in scholarship and presentation and (in different ways) deserve the attention they are likely to receive.

Dinosaur tracks have been studied for over two centuries (though their makers were not at first correctly recognized), and over the years a vast literature on them has accumulated, very ably reviewed by Thulborn. Through history, many paleontologists have tended to look down their noses at footprints and other trace fossils, often underestimating what they have to tell us. The traditional work was mostly descriptions of tracks or sites: find 'em, collect 'em, draw 'em, measure 'em, name 'em, file 'em, forget 'em. The most adventurous work was usually in trying to guess the identity of the track-maker, often with (to our eyes) implausible or even hilarious anatomical and functional reconstructions. Few paid much attention to the sedimentary or biological context of trackways until the 1950s and 1960s, when workers such as Donald Baird, Frank Peabody, Georges DeMathieu, and Hartmut Haubold began to look more intently at their meaning. Baird in particular established rigorous methods for analyzing tracks, properly noting that these were not anatomical structures but records of transitory behavior. And, he added, there is no point wasting much time on badly preserved tracks, as so many taxonomizers have done.

Many younger workers, notably Martin Lockley, Paul Olsen, James Farlow, and Thulborn himself, have been instrumental in adopting new approaches to trackways. Many of these have been experimental, involving recent animals and a variety of actual substrates. And a lot of new work has overturned traditional identifications of track-makers and views about their locomotion. In 1986, at the First International Symposium on Dinosaur Tracks and Traces, Wann Langston and Adolf Seilacher led a strong new emphasis on the sedimentological context of tracks, noting the importance of the composition and competence of the substrate in influencing footprint form and warning how easily one can be misled by underprints, or "ghost tracks," in reconstructing the identity of track-makers and their behavior. This emphasis should spur a lot of new work.

Thulborn's emphasis in this book is mainly the basics of fossil footprints: what they are, how they are collected and described, and how their makers have been assigned to them. He is particularly good reviewing the recent literature on dinosaur speeds and gaits. His command of the vast literature is especially impressive, typically strong and unusual in coverage.

Dinosaurs, Spitfires, and Sea Dragons is a great engaging exploration of the functional morphology, physiology, and structural mechanics of extinct reptiles, plus the obligatory chapter on extinction. McGowan nicely covers ground probably familiar to most specialists, but with a strong emphasis on the lessons that living animals can teach us about fossil ones. He is especially effective exploring the analogies between large living herbivores, such as giraffes and elephants, and giants of the past. The question of dinosaurian physiology, often simplified as "warm- vs. cold-bloodedness," is given a thorough going-over: the treatment here will enlighten, but not confuse, even the typical undergraduate. Of course there are minor gripes. I would have been perhaps less conservative in conclusions about dinosaur physiology, and I think that perhaps uniformitarian analogies to recent forms are accepted rather too casually at times. But there is more than just good heuristic discussion here. Students and professionals alike will benefit from this book.

In omitting the phylogenetic perspective these two books surprisingly fail to take advantage of what is the greatest advance in our knowledge about dinosaurs during the past decade: clarification of their evolutionary relationships. It is not simply that new phylogenies of major dinosaur groups have been advanced and (more or less) established; more important, the usefulness of phylogenies in answering more complex evolutionary questions has proven so great that no paleontological study is complete without rooting hypotheses in phylogeny. So it is curious that, for example, Thulborn divides track types into "small ornithopods," "iguanodonts," and "hadrosaurs," when these are really nested sets of the same group, and ponders the question whether fossil tracks belong to theropods or birds, when in fact birds *are* theropods. Discussions of track-makers and of the evolution of locomotory types should be coordinated with this kind of knowledge. McGowan leaves questions of phylogeny and what it can tell us about the evolution of function and physiology almost entirely out of his book. And this is a real tragedy. How can one consider the problems of the great size of brachiosaurs, the evolution of the bizarre skull crests in duckbills, or the elegant flight of *Pteranodon* without exploring the evolutionarily intermediate stages represented by other groups in a phylogeny?

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A Repopulation

After the Ice Age. The Return of Life to Glaciated North America. E. C. PIELOU. University of Chicago Press, Chicago, IL, 1991. x, 366 pp., illus. $24.95.

As the most recent period of geologic history, the Quaternary (Ice Age) is potentially the best known. That is especially true of the most recent deglacial hemicycle that spanned the past 20,000 years. In glaciated North America the ground is littered with fresh (and sometimes frozen) evidence of events just past; and most living things in the region have their histories intimately