effort during the Second World War to develop a source of this vital commodity to replace supplies from the plantations in South-East Asia, which were then under the control of the Japanese. The war effort depended on rubber — each Sherman tank contained half a ton of rubber, each bomber one ton and each battleship had 20,000 rubber parts weighing a total of 160,000 pounds (355,555 kg). Botanists were pressed into service in support of the war effort, for example in the collection of crucial raw materials such as quinine and rubber, species native to the neotropics.

The goals of the rubber programme were to estimate production that could be expected from wild rubber stands, to help support the initiation of production, and to collect seeds of important germplasm for a plantation industry to be established in the New World. Davis describes the botanical exploration, scientific productivity and extraordinary results that always characterized Schultes's work. As a result, germplasm collections, breeding programmes and rubber plantings were established in the Americas, ensuring that the United States and its allies would never again be held hostage to the supply of this vital commodity. Sadly, in 1954, Rey M. Hill, a State Department bureaucrat, succeeded in terminating the rubber programme, and the genetic material and plantations that Schultes and so many others had worked on were ploughed into the ground.

Today there is a new threat, biological rather than political, to the bulk of the world's rubber supplies — a leaf blight that could rapidly destroy the genetically homogeneous South-East Asian plantations. Unfortunately, the germplasm used to establish plantations in South-East Asia has no real resistance to the disease. As Davis states: "A single act of biological terrorism, the systematic introduction of fungal spores so small as to be readily concealed in a shoe, could wipe out the plantations, shutting down production of natural rubber for at least a decade. It is difficult to think of any other raw material that is as vital and valuable."

One River is an engaging and provocative read, a captivating story of past and present botanical exploration of the Amazon rainforest. Schultes and Plowman have served as mentors and role models for many tropical botanists, including this reviewer. This extraordinary book tells their story in a way that will inspire many others to carry on their work, at a time when the rate of loss of biological diversity and indigenous cultures has reached tragic proportions. □

Michael J. Balick is at the Institute of Economic Botany, New York Botanical Garden, Bronx, New York, New York 10458-5126, USA.

Flight from reason

Mark A. Norell and Luis M. Chiappe

The Origin and Evolution of Birds. By Alan Feduccia. *Yale University Press: 1996. Pp. 420. $65, £45.*

ALAN Feduccia's new book is a revision of his widely read *Age of Birds*, first published in 1980. It is organized in a loose systematic framework, taking each of the main groups in turn with a few introductory and summary chapters on bird biology, origin and evolution. Coverage of fossil specimens is extensive, but the illustrations are largely recycled and the photographs murky. With recent fossil discoveries, renewed interest in avian palaeontology and advances in systematic methodology, it should be an important book.

Unfortunately, if one digs a little deeper the goblins emerge. Early on, Feduccia states that "cladistics does represent the most rigorous method for the analysis of morphology", and the book is rife with cladograms. Yet he applies a sort of self-critical evolutionary taxonomy for the 1990s that reflects a misunderstanding of modern phylogenetic methods. This ambiguous approach clouds and obfuscates nearly every discussion in the book. Take the following examples.

The author claims that "the semilunate carpal in *Archaeopteryx* has assumed great significance because a superficially similar element has been found in a handful of theropod dinosaurs and has thus been hailed by some paleontologists as a definitive character linking birds to a theropod ancestry". This wrist-bone is one of several characters supporting the hypothesis that birds are dinosaurs. Feduccia seems surprised that the presence of this bone in "only four types of dinosaurs" (actually many more) can be used as evidence for their relationship to birds. But he seems to miss the point that birds are not equally related to all dinosaurs but are preferentially related to a subset having this feature.

In his zeal to demonstrate that *Archaeopteryx* is "in the modern sense a bird", he fails to cite recent papers indicating that its gait was more similar to that of several non-avian dinosaurs than to birds, and that its wrist and other postcranial bones as well as the skull are substantially more primitive than their modern counterparts. And after giving an accurate account of the discoveries and life styles of the Enantiornithines, the most diverse group of Mesozoic birds, Feduccia says that "it is clear that *Archaeopteryx* is much more closely related to the Enantiornithes than it is to modern birds". Yet he fails to give references to the many cladistic analyses rejecting their purported close relationship.

The author relies too much on the fossil record. He states that "...nor is there any substantial evidence that, with the exception of shorebirds, any modern avian groups extend past the Tertiary back into the Cretaceous" and that Mesozoic birds "underwent a dramatic and cataclysmic late Cretaceous demise". He does not warn readers (most of whom will not be palaeontologists) about just how spotty the Cretaceous fossil record is, and is careless in ignoring published work reporting modern avians in the Cretaceous. All this aside, on phylogenetic grounds, even the simple presence of shorebirds in the Cretaceous implies that many other modern taxa had already differentiated.

The same problem arises when the author states that the non-avian dinosaur relatives of birds are late Cretaceous in age, which, in his view, obviates the possibility that they could be related to the late Jurassic *Archaeopteryx*. This ignores recent discoveries of many members of these groups in coeval or nearly coeval beds. His logic also implies that humans and chimpanzees cannot be closely related because the earliest representatives of our own line appear more than 10 million years ago, whereas fossils on the chimp line are known only from the past million years or so.

Finally, Feduccia emphasizes similarities in function combined with 'special knowledge' ("intuitively pleasing" in his own words) as his basis for determining homology. Criticism of 'special knowledge' is self-evident. What is more, characters of vastly different function (such as tetrapod forelimbs or vertebrate postdentary bones) are homologues, and function has been deemed irrelevant to the issue of homology in modern systematics. Feduccia's misunderstanding of homology is clear in his discussion of the evolutionary importance of the furcula or wishbone. This element, homologous to the collarbones of other tetrapods, is present in birds and a variety of non-avian theropods. But Feduccia writes that "degeneration of the furcula with the evolution of flightlessness proves that it is intimately involved in the flight apparatus and argues strongly that whatever these structures are that are found in late Cretaceous dinosaurs, they are very likely not homologous with the furcula of birds". Obviously, to Feduccia the wishbones of non-avian theropods and birds cannot possibly be homologous simply because non-avian dinosaurs do not fly.

This book should have been much better; a well-illustrated volume detailing the history and biology of birds in a modern phylogenetic context is sorely needed. Until such a volume appears, we must still rely on the primary literature. □

Mark A. Norell is in the Department of Vertebrate Paleontology, and Luis M. Chiappe is in the Department of Ornithology, American Museum of Natural History, 79th Street at Central Park West, New York, New York 10024-5192, USA.