conservatives, unwilling to let the young Turks get away with announcing preliminary results that might later turn out to need substantial modification or withdrawal.

The course of cosmology is littered with such failures. Against the odds — and because of the experimental genius of two remarkable scientists, Mather and Smoot — COBE turned out to be a great success. □

Joseph Silk is at the Institut d'Astrophysique, 98 bis, Boulevard Arago, F-75014 Paris, France. He is on leave from the University of California, Berkeley, USA.

Flying yellow kangaroos

Tree Kangaroos: A Curious Natural History
by T. F. Flannery, R. Martin and A. Szalay. Illustrated by P. Schouten
Reed Books Australia: 1996. Pp. 202. A$100

Jared M. Diamond

In 1981, I finally succeeded in getting dropped by helicopter into New Guinea's highest, largest, most remote unexplored mountain range, the uninhabited Foja Mountains, which rise like an island out of lowland swamps. I dreamed of discovering there a population of diprotodonts, the rhinoceros-like giant marsupials that became extinct after humans arrived elsewhere in New Guinea and Australia. In the event, I had no luck with diprotodonts but did find New Guinea's long-lost golden-fronted bowerbird, as well as a remarkable large mammal.

The mammal was yellow, red and pink, with spots and stripes, about 1.5 metres long, and resting on the ground. It looked like a kangaroo but did not behave like one: when it saw me, it jumped up a tree.

No, I was not delirious with malaria. The strange apparition was a tree-kangaroo, one of a group of at least 10 species belonging to the genus *Dendrolagus* and confined to New Guinea and tropical Australia. Tree-kangaroos are among the world's most unusual and most difficult-to-study large mammals. One quarter of the known taxa have been discovered only within the past decade, including two of the most divergent — a striking black-and-white species with a white star on its forehead, and a large black species with a strong smell. Little has previously been known about them, and most of that was unpublished or in obscure publications.

That has now changed with the publication of this book, whose text is by Timothy Flannery, Roger Martin and Alexandra Szalay, and whose magnificent paintings of every species and subspecies are by Peter Schouten. The book is full of new information ranging from anatomical dissections to results of radio-tracking under unspeakably miserable field conditions.

Unknown to science until 1990: golden-mantled tree-kangaroo.

Unlike the well known, open-country, terrestrial animals that the word 'kangaroo' conjures up to most of us, tree-kangaroos are largely arboreal. To reach that niche required a zigzag evolutionary sequence of adaptations.

From arboreal, clambering, possum-like ancestors with prehensile tails, kangaroos became highly modified for hopping on the ground, and then evolved a new set of adaptations to trees to become tree-kangaroos. One remarkable species — discovered only three years ago — has in turn shed those adaptations to become the sole terrestrial species of tree-kangaroo.

The lifestyle of arboreal tree-kangaroos required them to reverse millions of years of kangaroo evolution in many respects: saving weight by a 25 per cent reduction in muscle mass; developing long, strong, curved claws; big, powerful grasping forearms, and a rotator cuff in the shoulder (shared with humans but not with other kangaroos or most other mammals) to permit overhead use of the forearm; hind-feet that twist so the soles can face each other to grasp a tree trunk; hair whorls to shed rain (also shared with humans); and a tail tufted with long fur in some species, used as a counterbalance in climbing and as a rudder in 'flight'.

Those 'flights' are actually jumps to the ground from a height of 20 metres or more in the canopy. I know of no other big mammal that survives drops from such a height, even landing on rocks — imagine trying to do it yourself. But tree-kangaroos often make such leaps to avoid danger. The loud thuds of falling tree-kangaroos as they hit the ground were among the distinctive sounds that I heard daily in the Foja Mountains. The text gives hints of the ways in which the animals' bones, muscles and ligaments must have become modified to withstand such shocks.

Adaptations to diet are equally interesting. Most species are leaf-eaters, but some take roots and fruit, and a couple have been observed in zoo cages to hunt and kill birds. Faced with a hard-to-digest, toxic, bulky leaf diet of low nutritional value, tree-kangaroos evolved a low metabolic rate. They decrease rather than increase their metabolic rate at low ambient temperatures; spend 90 per cent of their time 'doing nothing' (that is, sitting and digesting); and have a complex stomach of several chambers, and regurgitate and rechew food, like cows chewing the cud.

A glance inside the stomach is guaranteed to disgust even the most hardened gastroenterologist: among the leaf fragments crawl more than 100,000 nematode worms of various shapes and sizes. The worms digest leaves, excrete usable nutritious compounds, and finally yield up their bodies (to the tree-kangaroo's acid-secreting stomach compartment?) which are far more digestible to the host than are the original leaves. So the worms may not be parasites but gut symbionts — an astonishing departure from the usual pattern of microbes as gut symbionts in ruminants, termites and other herbivores.

The authors describe differences between species in anatomy, altitudinal distribution (hot lowland rainforest to freezing subalpine scrub), odour (from chest or cloacal glands), scrotal weight (possibly correlated with differences in breeding system) and colour (ranging from black or black and white to red and yellow, and including some of the most brightly coloured of mammals). But these are only a few examples of the surprises held in store for us by tree-kangaroo biology.

This book is aimed not so much at the few dendrolagophiles among us, nor even at mammalogists in general, but at any biologist looking for a goldmine of scarcely explored adaptations — or just looking for a gorgeous book.

Jared M. Diamond is in the Department of Physiology, University of California Medical School, Los Angeles, California 90095-1751, USA.