# Making a real discovery

*T. Cavalier-Smith*

**Prochloron: A Microbial Enigma.** Edited by Ralph A. Lewin and Lanna Cheng. *Chapman and Hall: 1989. Pp. 129. £42, $53.*

EIGHTY years ago, Mereschkowsky suggested that chloroplasts of green plants and red, brown and other algae evolved from differently coloured symbionts that independently took up residence inside the cells of different protozoa. Although the origin of chloroplasts from prokaryotic (bacterial) symbionts has been firmly established for about a decade, it is still very uncertain whether chloroplasts evolved several times, as Mereschkowsky argued, or only once or twice.

Mereschkowsky's theory of multiple origins was given a considerable boost in 1975, when Lewin and Cheng showed that the photosynthetic green cells symbiotic in certain colonial seasquirts living on mangrove roots, sea shells and corals were not eukaryotic green algae, as previously thought, but gigantic green bacteria. What was most exciting about these bacteria was not their exceptional size (9–30 micrometres, a size more typical of eukaryotic cells) but the fact that they differed from cyanobacteria and resembled instead green-plant chloroplasts in two important respects: replacement of the blue or red phycobilin pigments by chlorophyll *b*; and the stacking of their photosynthetic (thylakoid) membranes. After first thinking of them as blue-green algae (now more often called cyanobacteria) Lewin therefore renamed these unusual green cells *Prochloron*, and placed them in a separate division which he called Prochlorophyta.

Many people concluded that Lewin and Cheng had discovered another of Mereschkowsky's hypothetical symbionts and that green-plant chloroplasts had evolved from *Prochloron* or some other prochlorophyte, whereas the phycobilin-containing chloroplasts of red algae and Glaucophyceae had obviously evolved from cyanobacteria. Expeditions to Pacific islands to collect material to test this idea have resulted in the publication of nearly 100 papers, whose conclusions are lucidly summarized in this excellent and valuable book.

Virtually everything significant known about *Prochloron* and its symbiosis with seasquirts is included, together with beautiful colour plates of the fascinating variety of didemnid seasquirts that harbour *Prochloron*. In several cases the seasquirts clearly gain nutritionally from cultivating *Prochloron* in their bodies.

The main evolutionary conclusion to be drawn is that *Prochloron* is really not as fundamentally different from cyanobacteria as was once thought, and is probably not specifically related to the chloroplasts of green plants. Both Lewin and Stackebrandt now tend to accept the view, long argued by Chadefaud and myself, that *Prochloron* evolved from a cyanobacterium (by the loss of phycobilisomes and the associated evolution of chlorophyll *b* and thylakoid stacking) quite independently of green plant chloroplasts. Alberte suggests some possible selective advantages for these changes.

The recently discovered free-living prochlorophyte *Prochlorothrix*, to which the final chapter is devoted, also appears not to be specifically related to green chloroplasts. Because of the possibility of convergent multiple losses of phycobilisomes and origins of chlorophyll *b* (which differs from *a* in only one atom), one cannot even be sure that the prochlorophytes are monophyletic. It also remains possible, though perhaps unlikely, that green plants obtained their chloroplasts from the same cyanobacterium as did red algae but that euglenoids got theirs from a prochlorophyte. The discovery of a third unnamed type of prochlorophyte suggests that prochlorophytes could be more diverse than initially thought: even *Prochloron* should probably be split into at least three species. Atypical photosynthetic bacteria continue to be discovered sufficiently frequently to suggest that still more surprises may lie ahead.

Both Lewin and Stackebrandt touch on the problem of classifying the prochlorophytes. This group obviously belongs in the Eubacteria, not in the plant kingdom, despite Lewin's original creation of the botanical division Prochlorophyta. But the likelihood that these organisms evolved from cyanobacteria is insufficient reason to include them within the same family as cyanobacteria, as Stackebrandt suggests; that would be confusing and would undervalue their distinctiveness. The paraphyletic and exceedingly diverse class Photobacteria clearly should be abolished, as Stackebrandt implies. But instead one should treat Cyanobacteria and Prochlorobacteria (a better name than Prochlorophyta) as classes within a single new division — the Phycobacteria ('algal' bacteria) — which would include all those bacteria sharing the property of oxygenic photosynthesis with their descendants the chloroplasts. Phycobacteria differ sufficiently profoundly from purple and green anoxygenic bacteria to be a separate division.

An unusual and valuable feature of the book is the inclusion of abstracts of all the papers that have been published on *Prochloron*, which nicely complement the more discursive chapters on its cytology, biochemistry, symbiosis and phylogeny. The editors' very practical, and sometimes amusing, hints for collecting and handling *Prochloron* complete a first-rate work, the first devoted to the Prochlorobacteria. □

*T. Cavalier-Smith is a fellow of the Canadian Institute for Advanced Research (Evolutionary Biology Program) and is a professor in the Botany Department, University of British Columbia, Vancouver, British Columbia, Canada V6T 2B1.*

# Sitting on the fence

*David Lindley*

**Cold Fusion: The Making of a Scientific Controversy.** By F. David Peat. *Contemporary Books; 1989. Pp.188. $16.95.*

YOU would think that anyone writing about the cold fusion affair would be sensitive to the dangers of hasty publication. Not F. David Peat, apparently. Like Stanley Pons and Martin Fleischmann, who went public on the basis of what turned out to be highly disputable results, Peat has produced an account of cold fusion based on skimpy research and incomplete data. He also shies away from pronouncing judgement. This may be partly because his story comes to a halt during September 1989, when it was still possible (with a little effort) to imagine that there might be something to Pons and Fleischmann's claims, but is more a consequence of Peat's complete reluctance even to try to sift from the assertions and counter-assertions any measure of truth.

Peat's telling of the story adds little to what anyone who followed the comprehensive newspaper and magazine coverage will already know. Even so, Peat makes some mistakes with his chronology: he conflates the Materials Research Society meeting in San Diego, at which Robert Huggins unconvincingly defended his claim for excess heat, with the Electrochemical Society meeting in Los Angeles, at which Pons and Fleischmann similarly defended their claim for excess heat.

Nor is Peat's account of the science of cold fusion very penetrating. Two chapters of the book are occupied with routine expositions of nuclear physics, 'hot' fusion, solar energy, the chemistry of palladium and so on. Observing the quantity of theoretical ideas thrown out in response to Pons and Fleischmann's claim, Peat says "theoretical physicists and chemists appear to have no problem in accounting for cold fusion", a sunny judgement presumably based on the notion that a thousand completely wacky ideas weigh about the same as one or two moderately plausible ones. But in order to maintain