BOOK REVIEW

Lynn Margulis, *Origin of Eukaryotic Cells*: 1970, Yale University Press, New Haven and London, 349 pp.

All contemporary forms of life, excluding the viruses, are composed of either of two very different kinds of cellular structural units: the relatively simple prokaryotic ('prenuclear') cell, which lacks a nucleus and is found in all bacteria and in one group of algae, the blue-green algae; and the more complex eukaryotic ('truly nucleated') cell, which is found in animals, plants, and several groups of protists, including the fungi, protozoa, and several algae. This provocative book describes in detail how the eukaryotes could have evolved from the more primitive prokaryotes by a process of hereditary intracellular symbiosis.

As pointed out by the author, this theory is not new; it has occasionally been advanced in past attempts to cope with the marked discontinuity between the lower prokaryotes and the more highly evolved eukaryotes. The value of this particular treatment, however, lies in its timely discussion of recent biochemical, cytological, genetic, geological and paleontological data which are relevant to this question.

Biologists generally agree that the wide variety of life seen within both the prokaryotes and the eukaryotes can be attributed to Darwinian evolution, i.e., the accumulation of mutations which are selectively advantageous. The same mechanism has classically been invoked to explain the transition from the prokaryotic precursor to the eukaryotic cell; it is at this point, however, that a persuasive alternative is offered – eukaryotes could have resulted from the symbiotic joining of several cells without nuclei.

The argument supporting this theory is logically developed. Deficiencies in the more classical evolutionary sequence of hypothetical events are indicated, and past classification schemes based on these assumptions are critically evaluated and found wanting. The symbiotic theory is presented, whereby a prokaryote could have initially acquired certain cell organelles by the process of hereditary endosymbiosis. For example, a heterotrophic anaerobic prokaryote could have become aerobic when it ingested without digesting a smaller mitochondrial-like prokaryote (i.e., the 'protomitochondrion'). When several spirochaete-like prokaryotes (i.e., the 'protoflagella') became associated with the surface of these mitochondria-containing prokaryotes (i.e., the 'protokaryotes'), motility would have resulted. The protoflagellum could have served as the evolutionary precursor to the flagellum with its $(9 + 2)$ structure and the centrioles and dividing chromosomal centromeres of the contemporary mitotic apparatus. Eventually, photosynthetic prokaryotes (i.e, the 'protoplastids') could have been acquired symbiotically by several aerobic, motile 'protoeukaryotes', thus conferring photosynthetic ability upon their hosts. By successive hereditary intracellular relationships such as these, the gap between the prokaryotes and the eukaryotes could have been spanned.

The hypothetical relationships and processes just outlined are described in depth by the author, using data obtained from several fields. On the whole, this book has much to recommend it. References, photographs, electron micrographs, and figures abound throughout the text. Tables are used extensively to summarize important points or relatively large areas of knowledge. Deductions and predictions based on several of the mechanisms or relationships proposed are carefully considered, and areas in which more research is needed are defined. Implications for the origin of life are explored, and examples of contemporary symbiotic relationships analogous to those proposed are frequently discussed.

Since all biologists do not subscribe to the possibility that the eukaryotic cell could have arisen endosymbiotically among prokaryotes, this enthusiastic book may well stimulate both discussion and research. Although the extensive use of biological terminology and occasional redundancy might slow the reader somewhat, this generally excellent book may be expected to have an interdisciplinary appeal to all those interested in both chemical and biological evolution.

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