

PREFACE

In plants the plastids are almost certainly to be regarded as differentiations of pro-toplasmic substance

K. Mereschkowsky 1905; English translation by Martin and Kowallik (1999)

Prior to the invention of electron microscope in 1931, a prominent Russian biologist and botanist named Konstantin Sergeevich Mereschkowski proposed the endosymbiotic origin of cell organelles in a 1905 publication. More than 60 years passed before Lynn Margulis revisited Mereschkowski's unprecedented hypothesis, and eventually biologists began to accept that the plastid descended from an ancestor of extant cyanobacteria. To manufacture carbohydrates, and concomitantly release oxygen, photosynthetic plastids (i.e. the chloroplasts) capture energy from sunlight and combine that energy with carbon dioxide and water. Plastid genomes, referred to as plastomes in this book, encode many key proteins that are not only vital for regulation of photosynthesis but also play fundamental roles in the synthesis of nucleotides, amino acids, fatty acids and numerous primary metabolites as well as secondary compounds. Therefore, plastomes are crucial to the development of photosynthetic eukaryotes and to their interactions with the environment. In the past decade, advances in high-throughput sequencing technologies have expedited the accumulation of plastome sequences for examining their evolution, the function of plastid-encoded genes and their interaction with nuclear genes. Information about the organization and evolution of plastomes has also played a crucial role in plastid genetic engineering to enhance crop species and to produce pharmaceuticals. Finally, plastome data have played a pivotal role in resolving the phylogeny of photosynthetic organisms.

This book brings together expert contributors who have been working on plastid genome variation and evolution across photosynthetic eukaryotes. The topics range from the diversified plastome architecture of single-celled photosynthetic eukaryotes to seed plants; from the causes and consequences of genomic diversity to the phylogenetic utility of plastomic sequences for resolving relationships across the photosynthetic tree of life. Presently over 41,000 complete plastome sequences (as of April 27, 2017) are available in the National Center for Biotechnology Information (NCBI) organelle genome database. Novel software and comparative plastomics have modified our views on plastome architecture and made tremendous contributions to the resolution of evolutionary relationships within many clades. In terms

of plastome organization it is now widely recognized that plastomes are not predominantly circular but instead occur as linear and/or branched molecules that can form more complex multisubunit structural variants that can recombine. Moreover, dominant and subdominant forms have been detected in a number of seed plant lineages. There have been several recent examples of invasion of foreign DNA from the mitochondrion into the plastome, a phenomenon that is likely to be more prevalent as additional plastomes are sequenced. Plastome data have also been instrumental in identifying the earliest diverging flowering plant as *Amborella*, a problem that had vexed plant scientists since Darwin referred to it as an abominable mystery. This volume presents novel insights into this exciting field from leading experts in plastome evolution, including a comprehensive coverage of plastid genome variation in a broad range of taxonomic groups, from protists and multicellular algae to the major clades of land plants. Plant scientists and students in the fields of molecular biology, biotechnology, evolution, phylogenetics, horticulture and agriculture will be prospective readers. We hope that readers find this volume a useful summary of up-to-date work on plastome evolution.

The 11 chapters of this volume have been written with the goal of illuminating plastome evolution across a wide diversity of photosynthetic eukaryotes since their endosymbiotic origin approximately 1.5 billion years ago. We made an effort to provide coverage of all major photosynthetic lineages, but due to page limitations some groups have not been included. Although the topics are technical in nature, each chapter was written in an attempt to be as comprehensible as possible by nonspecialists and students.

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Reviewers: John F. Allen, Andrew Alverson, Craig Barrett, Shu-Miaw Chaw, Philippe Delavault, Joshua P. Der, Richard Dorrell, Chris Blazier, Romain Gastineau, Wenhui Guo, Robert K. Jansen, Patrick Kociolek, Shao-Lun Liu, Wolfgang Löffelhardt, Michael Moore, Jeffrey P. Mower, Vincent Savolainen, Thomas Pfannschmidt, David R. Smith, Monique Turmel, Mao-Lun Weng, Chung-Shien Wu and Hwan Su Yoon.

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REFERENCE

- Martin, W., & Kowallik, K. V. (1999). Annotated English translation of Mereschkowsky's 1905 paper 'Über Natur und Ursprung der Chromatophoren im Pflanzenreiche'. *European Journal of Phycology*, 34, 287–295.