Preface

The contributions to this volume center around the consequences that occur when different genomes come together. This seemingly simple process nevertheless transects several outstanding problems in biology, for example, the genetic and molecular mechanisms of hybrid vigor and speciation, as well as the contribution of polyploidy formation to evolution and agriculture.

Hybrid vigor or heterosis plays an important role in evolution and population biology as evidenced by the fact that most groups of eukaryotic organisms have evolved mechanisms to insure outcrossing. The increase in biomass and fertility as a result of heterozygosity in most plant species provides an evolutionary advantage, but this phenomenon has also found widespread use in breeding and agriculture with the use of hybrid production in many crops, vegetables, and some farm animals. Despite this widespread use in practical applications and a central role in evolutionary processes, both the genetic and molecular bases of heterosis have defied elucidation. Several authors have summarized the evidence from diverse species and from several different perspectives that can be brought to bear on this important topic.

The basis of speciation is likewise enigmatic. It has been recognized for decades that there are genetic incompatibilities that exist between species that can lead to hybrid sterility or lethality, postzygotically. Within a species, this usually does not occur. However, with divergence, the differences that accumulate can prevent gene flow between related species because of the detrimental consequences of hybridization. The nature of these genetic and molecular differences is only beginning to be discovered. Several authors describe experiments that address the molecular consequences that arise in hybrids between species. The bases of these incompatibilities may be many, but they lie at the heart of speciation mechanisms. The differences in specific genes and noncoding RNAs that evolve in different evolutionary lineages to condition incompatibilities will ultimately define how speciation operates, which will shed light on this critical evolutionary and biological issue.

Crosses between different species can also result in the formation of polyploidy if the hybrid doubles its chromosome number. While newly formed polyploids often exhibit detrimental qualities, polyploidy has clearly played an important role in evolution as revealed by the repeated histories of chromosome doubling in most eukaryotic lineages including fungi, protozoa, plants, and vertebrates. It is thus an important research question to address the qualities of polyploidy that lead to this central position in evolution. Moreover, the production of allopolyploids intersects with heterosis because it basically fixes the hybrid vigor for subsequent generations without the possibility of inbreeding reducing the diversity of gene copies between the two genomes contributing to the allopolyploid.

By bringing together a wide spectrum of information about polyploidy and hybrids in one volume, our hope is that it will serve as a valuable resource on this topic. But more importantly, it can serve

as an inspiration to address critical biological problems that have defied solutions but that play a central role in evolution and agriculture.

James A. Birchler, Columbia, Missouri
Z. Jeffrey Chen, Austin, Texas