



Fig. 1. Cladogram showing phylogenetic relationships among the major groups of extant eukaryotes, with emphasis on plastid-containing groups and their evolutionary connections via primary and secondary endosymbiosis. This estimate of relationships is modified from Keeling (2004) and Baldauf et al. (2004), which should be consulted for more inclusive trees showing additional groups of nonphotosynthetic eukaryotes. The names and circumscriptions of the five eukaryotic supergroups (Excavates, etc.) are from Keeling (2004), except that we have used “Primoplantae” (J. D. Palmer, unpublished manuscript) in place of “Plants.” Colors distinguish the three lineages of primary plastid-containing eukaryotes (Primoplantae) and also mark those eukaryotes with secondary plastids of red or green algal origin. The exact placement of the “symbiosis” arrows is arbitrary; essentially nothing is currently known about the timing of these events or the specific nature of the donor lineages. Two, probably independent, green algal secondary symbioses are shown, whereas the number of red algal symbioses could be as few as one (as shown) or, less likely, as many as five (see text). The three slashes indicate loss of plastids under the hypothesis of a single early red algal secondary symbiosis and Chromalveolate monophyly. “Other charophytes” denotes what is most likely a grade of four orders from which the Charales/land plant clade has arisen (Karol et al., 2001; Lewis and McCourt, 2004). Groups covered by a particular article in this special issue are circled and connected to the names of the article’s authors. Branch lengths in this cladogram are entirely arbitrary; no implications with respect to time are intended.