Expansion of signal transduction pathways in fungi by extensive genome duplication

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Details

Abstract

Plants and fungi use light and other signals to regulate development, growth, and metabolism. The fruiting bodies of the fungus Phycomyces blakesleeanus are single cells that react to environmental cues, including light, but the mechanisms are largely unknown [1]. The related fungus Mucor circinelloides is an opportunistic human pathogen that changes its mode of growth

upon receipt of signals from the environment to facilitate pathogenesis [2]. Understanding how these organisms respond to environmental cues should provide insights into the mechanisms of sensory perception and signal transduction by a single eukaryotic cell, and their role in pathogenesis. We sequenced the genomes of P. blakesleeanus and M. circinelloides and show that they have been shaped by an extensive genome duplication or, most likely, a whole-genome duplication (WGD), which is rarely observed in fungi [3-6]. We show that the genome duplication has expanded gene families, including those involved in signal transduction, and that duplicated genes have specialized, as evidenced by differences in their regulation by light. The transcriptional response to light varies with the developmental stage and is still observed in a photoreceptor mutant of P. blakesleeanus. A phototropic mutant of P. blakesleeanus with a heterozygous mutation in the photoreceptor gene madA demonstrates that photosensor dosage is important for the magnitude of signal transduction. We conclude that the genome duplication provided the means to improve signal transduction for enhanced perception of environmental signals. Our results will help to understand the role of genome dynamics in the evolution of sensory perception in eukaryotes.

Beteiligte Forschungseinheiten

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