Testing Functional Diversification of the Retinoblastoma Pathway in Volvocine Algae

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Abstract

Background: The retinoblastoma (RB) tumor suppressor pathway functions as a switch controlling cell cycle progression, typically the G1→S phase transition. The Chlamydomonas RB-related protein MAT3 controls the timing and extent of cell division, and its loss in a *mat3* null mutant leads to small cells due to supernumerous rounds of division during S/M phase. A recently published manuscript (Hanschen, E.R, et al,2006) reported that the *Gonium MAT3/RB* gene (*GpMAT3*) was not only able to complement the small cell size defect of a *Chlamydomonas mat3* null mutant, but to alter its cell cycle programming and cause it to become colonial. The authors hypothesized that *GpMAT3* underwent natural selection as a key "multicellularity" gene, a finding that has major implications for the evolution of multicellularity in the volvocine clade. Methodology/Principal Findings: Here carefully examined the phenotypes of the *mat3::GpMAT3* strains and determined that their clumpy phenotype has nothing to do with a modified cell cycle, but is probably related to stress and suppression of flagella formation. The only relevant cell cycle difference we did find is a slightly larger daughter cell size in *mat3::GpMAT3* strains compared with wild-type Chlamydomonas cells. This difference mirrors the daughter size differences between the two species where Gonium daughters are larger than Chlamydomonas daughters, but is not directly relevant to multicellularity in Gonium. Conclusions/Significance: Our data strongly refute a previous study implicating volvocine MAT3/RB as a multicellularity gene, but do confirm that there is an evolved partial incompatibility between the GpMAT3 protein and other components of the RB network in Chlamydomonas that leads to clumping when GpMAT3 is expressed in Chlamydomonas. Clumpy phenotypes arise in cells that have defects in flagella formation, defects in secretion of hatching enzyme, or sometimes in response to prolonged stress. Our preliminary data do not show any flagella gene expression defects in *mat3::GpMAT3* transformants suggesting that inappropriate activation/repression of other genes by ectopically expressed GpMAT3 may activate a stress response in these strains and cause them to clump.

Reference

Hanschen ER, et al. (2016) The Gonium pectoral genome demonstrates co-option of cell cycle regulation during the evolution of multicellularity. Nat Commun 7:11370.