OA2.7 - Enriched Genomic Loci (EGL) mapping: Identification of genomic loci enabling increased photosynthetic efficiency and environmental fitness in *Chlamydomonas reinhardtii*

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Photosynthetic organisms have evolved complex mechanisms to regulate energy capture and storage under diverse and dynamic environments. Theoretically it is possible to exploit these strategies to increase photosynthetic energy capture and biomass production under industrially relevant conditions. However, a major impediment to this strategy has been disentangling the complex interactions between the genetic and physiological factors contributing to productivity and resilience. Here we demonstrate an approach to produce, select and characterize hybrid algae strains exhibiting increased photosynthetic productivity under multiple environmental conditions and identifying genomic loci that condition these responses. A pooled diversity panel of the model green alga *Chlamydomonas reinhardtii* with nuclear genomes shuffled by sexual recombination, were poly-cultured in competition under multiple environmental conditions. By tracking the enrichment or depletion of single nucleotide polymorphisms across the genome, we were able to identify "Enriched Genomic Loci" (EGL) that accumulated in the outcompeting population. The analysis is conceptually similar to the mapping of quantitative trait loci (QTLs) through association of phenotypes to genetic markers, but in our case the phenotype is survival and productivity. Strikingly, individual strains isolated from the outcompeting populations showed substantial increases in productivity or tolerance under both baseline and stressful conditions (hyperoxia, fluctuating light, high salinity or high temperature), indicating that *Chlamydomonas* has remarkable, untapped, phenotypic plasticity that may be harnessed through breeding and selection. Some EGL regions are currently quite large, over a Mb in size, while others are as small as 60 Kb suggesting that with refinements EGL mapping could be a powerful approach to understanding the genetic and mechanistic bases of increased photosynthetic productivity and environmental vigor.