Thrust Area 3: Biomass (Algae)

Optimization of Algae Species for Biofuels Production Using Genetic Alteration

PI: Edward Phlips
Student: Bailey Trump, PhD degree

Description: The central challenges to viable algal biofuel production are the solar energy conversion efficiency for algae growth, sustainable yields of usable products and operational constraints on production systems. While theoretical solar conversion efficiencies for algae and plants are between 5 and 6% of total insolation, most algal systems operate at average annual efficiencies well below this range. Therefore large areas are needed to produce significant amounts of biofuels from algae, and production systems must be able to sustainably produce biomass convertible to biofuels within reasonable logistical and economic constraints. Logistical constraints include minimal use of valuable freshwater and arable land resources. Economic constraints may demand the use of low tech open pond systems, rather than more costly and maintenance intensive closed bioreactor designs. Sustainability of production will depend on the ability to maintain relatively pure mass cultures of algae capable of producing high levels of desirable products (e.g. hydrocarbons or convertible lipids). These considerations point toward the need to focus on the development of systems which use ocean water and algal species adaptable to extreme conditions that minimize competition from "weed" species, such as high salinity, temperature, pH, low nitrogen availability or UV light exposure.

The focus of this study is genetic alteration of selected species of algae to optimize their performance in biomass production systems aimed at biofuels. Two approaches to genetic alteration will be explored, mutagenesis and transformation. The research program began with the use of chemical mutagens to generate altered strains of algae currently available in the culture collection of the PI (E. J. Phlips). Mutated algae are going through a selection process to identify strains with favorable characteristics. The selection criteria include growth rate, tolerance to environmental extremes (e.g. salinity, temperature, pH, UV exposure), and lipid content. The initial target species for mutagenesis research will include: 1) *Botyrococcus braunii*, a green alga (Chlorophyta) known for its high levels of hydrocarbons, but low growth rates and low adaptability to high salinities and temperatures, 2) *Synechococcus sp.* a fast growing cyanobacteria high biomass production potential, and adaptability extreme environmental conditions, such as high salinity and temperature.

Budget: $15,000
University: UF
Collaborators: Drs. Mathius Kirst in the University of Florida's Genetic Institute and Charles Guy in the Department of Environmental Horticulture at the University of Florida.

Progress Summary

The funds provided by FESC are being used to fund the dissertation research of Bailey Trump, a PhD student. The focus of her dissertation research is the **Optimization of Algae Species for Biofuels Production Using Genetic Alteration.** Her dissertation research program began in August of 2011. During the initial stages of her program she has begun the development of the methodologies for mutating and screening the target species of algae, in cooperation with Drs. Mathius Kirst in the University of Florida's Genetic Institute and Charles Guy in the Department of Environmental Horticulture at the University of Florida.

One of the two initial target species *Synechococcus* sp. was immediately available from the culture collection of the PI. The other species, *Botryococcus braunii* Strain B, was obtained through a cooperative agreement with the University of California at Berkeley (Dr. Irvin Mettler, Associate Director).

New Partnerships: A new research partnership was formed with Drs. Pratap Pullammanappallil of the Department of Agricultural and Biological Engineering (U. of Florida), Spyros Svoronos of the College of Engineering (U. Florida) and Ben Koopman of the College Engineering (U. of Florida) for the submission of a proposal to NSF's Emerging Frontiers in Research and Innovation 2012 (EFRI-2012) program. The proposal is titled Development of a Photosynthetic Biorefinery Employing a Novel Hypersaline, Nitrogen-fixing, Polysaccharide Secreting *Synechococcus s*p. of Cyanobacterium, and will be submitted in November 2011.