4-1-2013

Bioprospecting to Discover Local Algae for Biofuel Production

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EUREKA 2012 CALHOUN HONORS COLLEGE SUMMER RESEARCH CLEMSON UNIVERSITY

Abstract

Biofuel production from microalgae is a promising renewable energy endeavor. Most investigations to discover useful algal species focus on lipid production and growth rate but a challenge that receives less attention is harvesting the small cells in a low-energy manner. This project was the starting point for discovering algal species that could be easily removed from water by membrane filtration. Samples were taken from local water bodies to simultaneously evaluate dozens of non-invasive species. Algal genera were identified through bright-field microscope and scanning electron microscope (SEM) images. *Scenedesmus* was the most common genus identified, with *Euglena* and *Staurastrum* appearing repeatedly. After identification, agar plates were inoculated and algal growth was monitored to determine which species could be easily cultured. Filamentous algae like *Oedogonium gracilis* and *Fischerella* were the first to visibly grow in the agar plates out of the 21 genera identified. *Scenedesmus* was the next most prominent type. It is hypothesized that the filamentous algae are good candidates for harvesting because they can be filtered with minimal pore blocking. *Mallomonas* is another interesting species because its spiny structure would allow water passage. This project sets the stage for bench-scale harvestability tests to be conducted by the research group in the future, now that culturable genera with promising morphology have been identified.

Introduction

- ✧ Algae are transformed into biofuel using three steps: cultivation, harvesting, and conversion.
- ✧ Harvesting (dewatering) is a major bottleneck in the process[1].
- ✧ Harvesting can be done in various ways: Sedimentation, dissolved air flotation, or filtration
- ✧ Membrane microfiltration can be beneficial because it accomplishes near complete separation without chemical addition.
- ✧ A major problem with microfiltration is the energy cost, especially when fouling occurs.
- ✧ The overall goal of this work is to find algal species that are low fouling, then learn what makes them that way.
- ✧ The specific goal of this EUREKA! Project was to collect, identify, and culture local algal species.

Methods

- ✧ Collect algae samples from various sites.
- ✧ View under microscope and determine species to form a generalized idea of the algal community.
- ✧ Create agar-based growth plates in which to grow the cultures.
  - ✧ BG-11 Media was used in plates
- ✧ Inoculate plates and examine growing cultures.
- ✧ Analyze and interpret data in relation to the question of which is best for harvesting for biofuels.

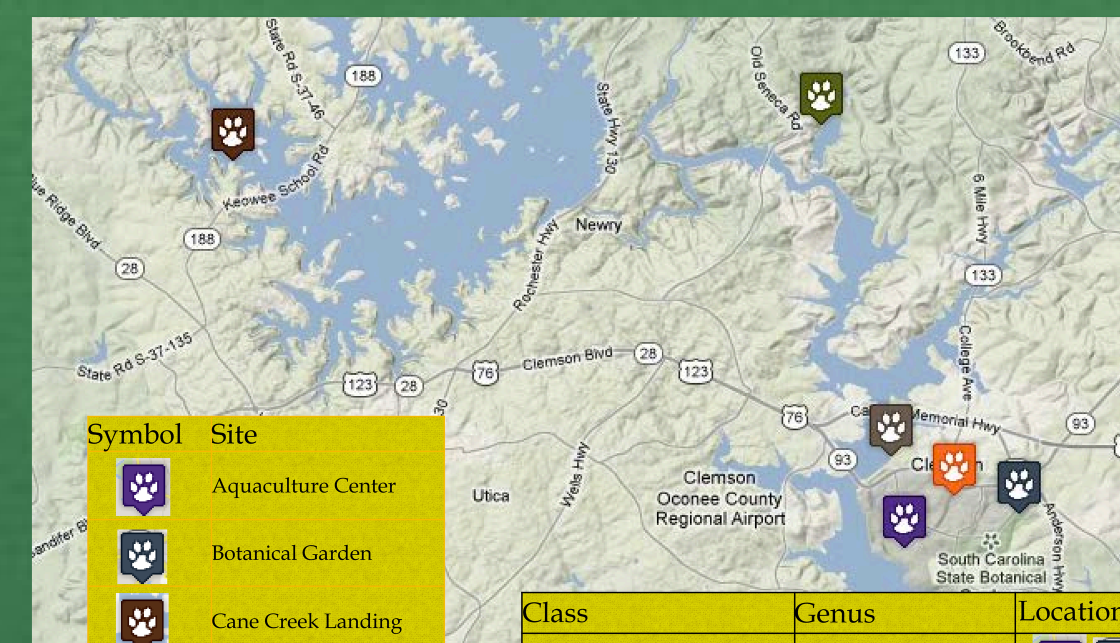
Bibliography

1 Wiley, Patrick, J. Elliott Campbell, and Brandi McKuin. (2011). Production of Biodiesel and Biogas from Algae: A Review of Process Train Options. *Water Environment Research, 83* (4). Retrieved on June 28, 2012 from online database.

2 Kenyon College. (2011, July 23). Biodiesel from Algae Oil. Retrieved July 29, 2012, from: http://microbewiki.kenyon.edu/index.php/Biodiesel_from_Algae_Oil.

3 Mandal, S. and N. Mallick. "Microalga Scenedesmus obliquus a potential source for biodiesel production." *Appl Microbiol Biotechnol*, March 28, 2009. Accessed July 29, 2012. Abstract retrieved from http://www.ncbi.nlm.nih.gov/pubmed/19330327.

Results



Symbol	Site
(purple)	Aquaculture Center
(dark blue)	Botanical Garden
(brown)	Cane Creek Landing
(green)	Issaqueena Lake
(gray)	Lake Hartwell
(orange)	Reflection Pond

Class	Genus	Location
Bacillariophyceae – diatoms (centric)	*Cyclotella comta*	Aquaculture Center, Botanical Garden
	Centric Filaments	Botanical Garden
	Podosira	Botanical Garden
Charophyceae	*Staurodesmus*	Lake Hartwell
Chlorophyceae	*Closterium*	Cane Creek Landing
	Cosmarium	Cane Creek Landing
	Eudorina or Pleodorina	Botanical Garden
	Kirchneriella	Botanical Garden
	Oedogonium gracilis	Lake Hartwell, Reflection Pond
	Pediastrum	Aquaculture Center
	Scenedesmus	Botanical Garden, Cane Creek Landing, Issaqueena Lake, Lake Hartwell
	Staurastrum	Aquaculture Center, Issaqueena Lake, Lake Hartwell
	Tetraedron	Botanical Garden
	Treubaria	Aquaculture Center
Chrysophyceae	*Mallomonas*	Botanical Garden, Lake Hartwell
Cyanobacteria (Cyanophyceae)	*Fischerella*	Reflection Pond
	Microcystis	Aquaculture Center
Euglenophyceae	*Euglena*	Aquaculture Center, Botanical Garden, Issaqueena Lake
	Phacus	Aquaculture Center, Botanical Garden
	Trachelomonas	Botanical Garden, Issaqueena Lake
Various	*Eladocera*	Reflection Pond
	Keratella	Botanical Garden
Xanthophyceae	*Tribonema*	Aquaculture Center, Botanical Garden

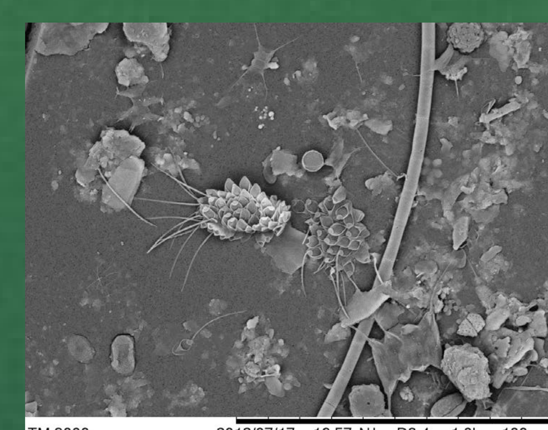


Figure 1 (above): SEM image of *Mallomonas* and others.

Figure 2 (below): SEM image of *Phacus* and others.

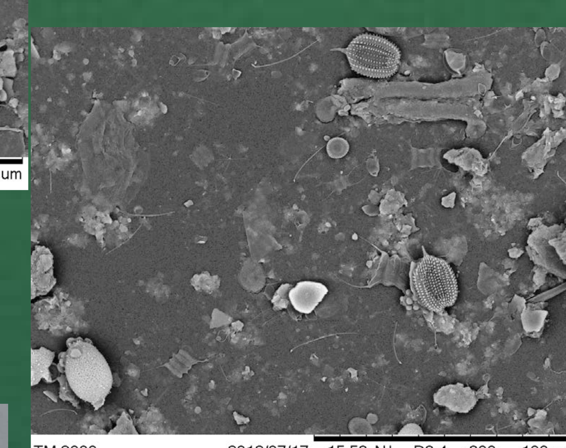


Figure 3 (above): Bright field microscope image of *Staurastrum*.

Figure 4 (below): Bright field microscope image of *Staurodesmus*.

Figure 5: Petri dishes containing inoculated agar plates in the lab.

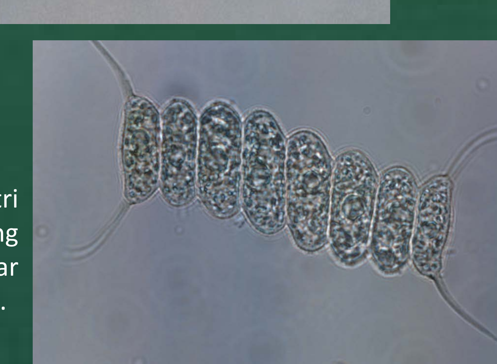


Figure 6 (left): Bright field microscope image of *Scenedesmus*.

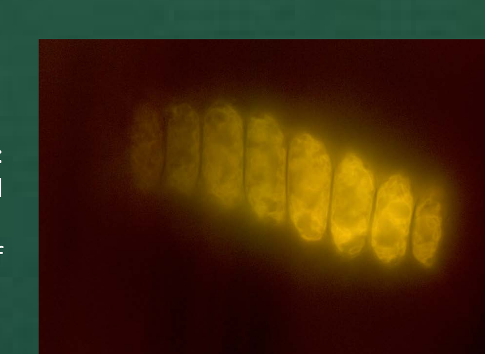


Figure 7: Same image as Figure 5, but in fluorescence.

Figure 8 (left): Bright field microscope image of *Keratella*.

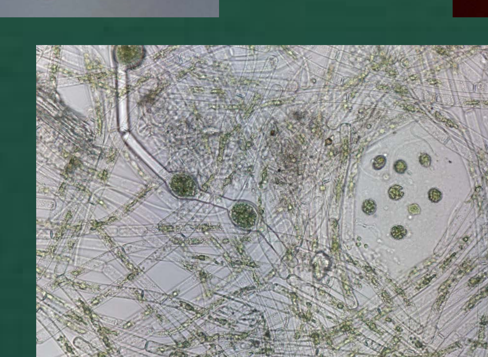


Figure 9: Bright field Microscope image of *Oedogonium gracilis*.

Discussion

- ✧ The Botanical Gardens had the highest biodiversity, most likely because it is somewhat stagnant and nutrient-rich.
- ✧ The benefits of growing local algae is that there would be less contamination (e.g. by invasive species) and it would be far more sustainable.
- ✧ The ideal algae for biofuels are *Chlorophyceae* (green algae) because of their high lipid content and quick reproduction time[2].
  - ✧ *Chlorella* and *Dunaliella* are preferred, but were not found at the sites
- ✧ *Scenedesmus*, a *Chlorophyceae*, was found at four of the sites.
  - ✧ This species is viewed as a feasible option for biofuels conversion[3].
- ✧ Another *Chlorophyceae*, *Oedogonium gracilis*, was found a two of the sights, and also is one of the filaments that is growing the quickest in the agar plated cultures.

Figure 10 (above): Bright field microscope image of *Scenedesmus*.

Figure 11 (below): SEM image of *Mallomonas* and *Cyclotella comta*.

For more images, scan the QR code (above) to access the online gallery.

Conclusion

The investigation into the harvesting process for biofuels is an ongoing process that will require significantly more data, particularly in regards to filtrations and biomasses of various algae. This project, however, is a starting point for investigations regarding the harvestability of local algae, and demonstrates that using local algae has benefits, such as relatively easy access to it. Certain algae prefer certain conditions, and the diversity found within this radius exhibits the variety of environments that are available locally. The most prevalent local species was the *Scenedesmus,* having been noted at four of the six sites, and *Staurastrum* and *Euglena* were seen at three of the sites. The filamentous algae (*Oedogonium gracilis*) found at a couple of the sites seems to be the best suited for growing in the plated cultures.

Acknowledgements

Clemson University and the Calhoun Honors College are gratefully acknowledged for support of the EUREKA! Program. Special thanks are given to Graham von Oehsen and Scott Davis for their help.