Bibliography from students in the plant biology course at St. John Fisher College, created on December 1st, 2014 under the tutelage of Dr. Michael Boller and Michelle Price. For more information, contact Dr. Boller mboller@sjfc.edu

## Archambault J, Bergeron C, Cope W, Richardson R, Heilman M, Corey J, Netherland M, Heise R. 2014. Sensitivity to freshwater molluscs to hyrilla-targeting herbicides: providing context for invasive aquatic weed control in diverse ecosystems. Journal of Freshwater Ecology. DOI: 10.1080/02705060.2014.945104.

Fluridone was exposed to various juvenile, adult, and glochidia mollusks in laboratory toxicity tests. The juveniles were of the unionid mussel *Lampsilis siliquoidea* and the adults and glochidia were *Lampsilis fullerkati.* The lethal fluridone concentrations for glochidia were 865 μg/L and 500 μg/L for the juveniles. There were no mortalities in the 28-day exposure and there was no statistically significant effect of fluridone concentration on foot protrusion (*p* = 0.06) or siphoning behavior (*p* = 0.08). It was found that freshwater mollusks are more sensitive to fluridone than other species. Fluridone concentrations typically recommended for hyrdilla treatments were not acutely toxic to mollusks and were not lethal to adults even at the highest concentration of 300 μg/L.

Maria Vangellow, Brittany O’Brien

Added December 2014

**Atul Puri, Gregory E. MacDonald, Fredy Altpeter and William T. Haller. Mutations in Phytoene Desaturase Gene in Fluridone-Resistant Hydrilla (Hydrilla verticillata) Biotypes in Florida. Weed Science Society of America(Sep. - Oct., 2007). [Accessed 04/11/2014]; Vol. 55, No. 5.**

The article was about a research that studies the mutations of the Hydrilla aquatic weed that develop a resistance to the Fluridone herbicide. Fluridone is an inhibitor of the enzyme Phytoene Desaturase, which stops the synthesis of carotenoid. The study found that different type of Hydrilla generates mutations at different nucleotide positions to develop a resistance to the herbicide. Mutation in the 304 amino acid has allowed the Hydrilla to form this alteration, and is hazardous to the controlling of this species

This is very important to note, because although this is not something that we are yet to be worried about in our region, it is still crucial that we are aware of the Hydrilla’s mutating abilities to our herbicides. It is important that we have back up herbicides, or other forms of control ready to maintain any rapid mutations of these organisms, and can prevent this invasive species form taking over. The Hydrilla’s ability to mutate can have devastating implications to our ecosystems, and can cause various changes in our population.

Edita Abazaga, Munif Almansoob
Added December 2014

**Benoit L, Les D. 2013. Rapid Identification and Molecular Characterization of Phytoene Desaturase Mutations in Fluridone-Resisnt Hydrilla (Hydrilla verticillata). Web of Science. 61(1): 32-40.**

This article explains they have seen some changes in populations of hydrilla in Florida have been showing some scary increases in their resistance to fluridone. Fluridone is a herbicide that has been used all over the United States to control hydrilla populations. Since hydrilla are becoming more and more of a problem in different bodies of fresh water all over the US the issue of them becoming resistant to one of the main herbicides used to control them could create an even larger issue. In this article they talk about how they created a PCR method so they could identify and screen the hydrilla DNA and see if they were truly growing a resistance to this herbicide. Given this herbicide is not used in all the states where the hydrilla is found, it just raises the issue that these plants can become resistant to then possibly any herbicide and could potentially get out of control in unwanted areas.

In the experiment 90 hydrilla that were screened for fluridone resistant genotypes came from different countries but in Florida is was found that five of the nine sites tested heterozygous for wild-type and herbicide-resistant alleles. They saw that all resistance-conferring mutations were located on the same homologous haplotype of the US dioecious hydrilla. They proposed that in order to avoid this resistance to herbicides that alternative treatments should be considered such as treatments that include nonPDS enzymes inhibiting herbicides. They also suggested physical control methods such as physically removing the hydrilla or stocking infested lakes with sterile carp that will eat the hydrilla.

Alyssa Gaffeny, Francesca Agostini

Added December 2014

**Bianchini Jr I, Cunha-Santino M.B., Dias J.H. 2010. Growth of Hydrilla verticillata (L.f.) Royle under controlled conditions. .. Hydrobiologia [Internet]. , cited 2010 May] Vol. 644 Issue 1. Available from:** [**http://web.a.ebscohost.com.pluma.sjfc.edu/ehost/pdfviewer/pdfviewer?sid=fd26a9f5-1454-4656-be3a-5f5bcf20d50e%40sessionmgr4003&vid=14&hid=4101**](http://web.a.ebscohost.com.pluma.sjfc.edu/ehost/pdfviewer/pdfviewer?sid=fd26a9f5-1454-4656-be3a-5f5bcf20d50e%40sessionmgr4003&vid=14&hid=4101)

Growth of H. verticillata measured under controlled conditions and compared the growth dynamics for the two development strategies, branch and tuber. The latter species has significant potential to develop in tropical aquatic ecosystems. Growth kinetics parameters showed a doubling time of 19.8 days for H. verticillata growing from stems, with growth from tubers even faster (doubling times from 2.5-11 days). To study the growth of the stems they were incubated under controlled conditions of 20.7 degrees celsius. In addition to the stem cultures 200 tubers were incubated in 2 glass flasks. The tubers were put under the same temperature and light conditions as incubation with the stems. The tubers were buried in sediment and filled with reservoir water having the water renewed weekly. The growth of the plants from the tubers were more intense growing 7.7 times more rapidly than the stems. These values showed the potential for growth of H. verticillata which is much more competitive than other species that live in the Neotropic regions. It was concluded that the high temperature and light availability found in most South American reservoirs are suitable for H verticillata to dominate. The optimum growth temperature for this macrophyte is between 20-27 degrees celsius, which is the optimal temperature, found in South America.

Ray Mertens, Adam Gosier

Added December 2014

**Binimelis R, Monterroso I, Rodriguez-Labajos B. 2011. New methods for the analysis of ivasion processes: Multi-criteria evaluation of the invasion of *Hydrilla verticillata* in Guatemala. Journal of Environmental Management. 92 (3). 494-507. http://sciencedirect.com.pluma.sjfc.edu/science/article/pii/S0301479710003038**

A study was performed to analyze the invasion of Hydrilla in lake Izabal Guatemala. This study was ran to examine and manage various socio-environmental conflicts effecting this species. This study showed the effects that this invasion had on other species and factors present in the lake. In this study, management scenarios were employed to evaluate technically and socially the impacts that Hydrilla had on the environment. One scenario was to take no action against the invasion. The second scenario was to use mechanical extraction to remove the Hydrilla from the lake. The third scenario was to employ numeral control strategies rather than just one strategy. The results showed that the scenario employing multiple methods of extraction was favorable.

Allison Corretore, Sydney Saccone

Added December 2014

**Cuda, J. P., Coon, B. R., Dao, Y. M., & Center, T. D. (2002). Biology and laboratory rearing of Cricotopus lebetis (Diptera: Chironomidae), a natural enemy of the aquatic weed hydrilla (Hydrocharitaceae). *Annals of the Entomological Society of America*, 95, 587–596.**

The authors of this source reveal that field and lab studies were conducted to determine the affects of Cricotopus lebetis on Hydrilla in Crystal River, FL. It was determined that the larvae of C. lebetis burrow into the apical meristems of the hydrilla and destroy the shoot tips. It was discovered that these larvae develop entirely on the living tissues of hydrilla, alluding to a way to control the invasive species.

James Romer, Mariah Barranco

Added December 2014

**Cuda, J. 2011. Effect of an herbivorous stem mining midge on the growth of hydrilla. Journal of Aquatic Plant Management. 49: 83-107.**

A major reason why hydrilla is invasive is because they produce thick surface mats. Larvae mine apical meristems of hydrilla, injuring or killing the growing tips. This prevented the stems from reaching the water surface. There was a positive correlation between larval density and the frequency of meristem damage. In the lab, 99% of biomass of hydrilla was reduced by larval feeding activity. This could reduce the production of the thick surface mats that come from uncontrolled growth. This would limit the impact on native plants and animals.

Chelsea Cleveland and Alyssa Ciancio

Added December 2014

**Dooris, Martin. 1985. Naturally Occurring Substances That Inhibit the Growth of Hydrilla verticillata. Volume 268. Amer Chemical Society; p381-386.**

An experiment was conducted to find what inhibits the photosynthesis of hydrilla. With the decrease in photosynthesis, cellular respiration increased. Scientists used chromatography to see if it was possible to take a sample of the body of water for analyzing hydrilla growth rate and potential. This is relevant because the growth of hydrilla has become an issue in various places in the United States and continuing to grow. Hydrilla is taking out native plants by using their resources and shading them out. The relevance of knowing the growth potential for hydrilla can help to make it so scientists can see how quickly is forms and hopefully prevent it.

Halie Schoff

Added December 2014

**Dooris, P, Martin, D. 1985. Naturally Occuring Substances That Inhibit the Growth of *Hydrilla* *verticillata*. American Chemical Society. p. 381-386.**

The researchers conducted an experiment using a cypress derived lake sediment and HPLC (high performance liquid chromatography) to isolate a single component that was bio-active. This component inhibits the photosynthesis of the hydrilla leaves and it was shown that the rate of respiration was accelerated. This research concluded that chromatography can be used, along a sample of the body of water, to determine the hydrilla growth potential and as a solution to control high levels of hydrilla.

Ciarra Bodnar and Katie Warner

Added December 2014

**Doyle R, Grodowitz M, Smart M R, Owens C. 2002. Impact of herbivory by Hydrellia pakistanae (Diptera: Ephydridae) on growth and photosynthetic potential of Hydrilla verticillata. Biological Control. 24 (3): 221-229.**

One of the largest problems for the North American waters is the presence of the Hydrilla *verticillata*. This plant is a major problem because of the rate at which it produces, the biomass of the plant, and the formation of a dense canopy above the other plants close to the surface of the water. According to the article it is described as the “perfect aquatic weed”. The best way to contain and control an invasive species when it becomes established in a non native region is to establish a native pest or biological agent that affects the invasive species negatively to control it. It is the safest way to control an invasive species. There is an herbaceous fly (Hydrellia *pakistanae*) that feeds on the Hydrilla *verticillata* this particular herbaceous relationship causes massive problems for the Hydrilla *verticillata*. It impacted the biomass and the growth morphology of the plant. Also there were impacts of the reproduction rate and the allocation of resources for reproduction, according to the article the reproduction of the plant was reduced by 85% in a controlled experiment. According to the article there was a decrease in photosynthetic activity, with 10-30% leaf damage, maximum rate of light and photosynthesis overall decreased by 60% in stems showing 70-90% leaf damage, again in a controlled experiment.

Kevin O’Donnell, Lucas Perriello

Added December 2014

**Hofstra,D, Clayton,J.2014.Native flora and fauna response to removal of the weed Hydrilla verticiliata (c.f) Royle in Lake Tutira.Hydrobiologia.(1):297-308.**

The article “Native flora and fauna response to removal of the weed *Hydrilla verticillata* (L.f.) Royle in Lake Tutira” by D. Hofstra and J. Clayton discusses the challenged associated with controlling hydrilla in New Zealand. This article also discusses how flora and fauna responded to the removal of hydrilla weed beds and their response to the introduction of grass carp in Lake Tutira. Fifteen sites were established in Lake Tutira to represent a variety of the habitat species present within the lake. Surveys were conducted every autumn from 2008 to 2012, in which a description of each site was noted.

In conducting this experiment, it was concluded that after the hydrilla beds were removed there was a statistically significant decrease in the flora and fauna in the lake. The milfoil myriophyllum triphyllum had a statistically significant increase and the pondweed potamogeton ochreatos had a statistically significant decrease. This experiment ultimately concluded that by removing hydrilla beds in Lake Tutira, has a positive effect because of the increase in the biodiversity within the lake.

Lydia Rossi, Nikki Rinehart

Added December 2014

**Jackson MA, Shearer JF. 2006. Liquid culturing of Microsclerotia of Mycoleptodiscus terrestris, a potential biological control agent for the management of Hydrilla. Biological Control. 38(3): 298-306.**

Microsclerotia of Mycoleptodiscus terrestris were produced in a liquid culture medium containing a basal salts solution supplemented with corn steep liquor powder and glucose. Hyphal aggregation, as well as hyphal and sporogenic germinations were observed.

They found that hyphae germinating from Microsclerotia on Hydrilla plant surfaces could establish initial infection sites followed several days later by secondary infections resulting from the development and release of spores from the surface of the Microsclerotia. Microsclerotia of Mycoleptodiscus terrestris can be used as a non-chemical, biological control agent for Hydrilla as long as the Microsclerotia can remain stable as a dry preparation and can germinate both hyphally and sporogenically upon rehydration.

Emily Haniford & Nykki Squires

Added December 2014

**Johnson KG, Dotson JR, Pouder WF, Trippel NA, Eisenhower RL. 2014. Effects of hurricane-induced hydrilla reduction on the largemouth bass fishery at two central Florida lakes. Lake and Reservoir Management. 30: 217-225**

Two lakes in Florida, Lakes Weohyakapka and St. Johns Water Management Area, had hurricanes in August and September of 2004. These hurricanes depleted substantial hydrilla from the waters. Because of this changes in the population of largemouth bass, recreational fishing, angler expenditures, and trophy fishing were investigated for pre and post hurricane lakes. It was found that pre hurricane conditions had more juvenile largemouth bass than post hurricane conditions. This was suspected to be because of lack of hydrilla after the hurricanes. After the hurricanes, fishing efforts in these water declined exponentially, most likely because of lack of hydrilla. Fishing anglers instead adapted their fishing techniques to other structures. In Lakes Weohyakapka and St. Johns Water Management Area the anglers used giant bulrush. The loss of hydrilla in these waters led to a decline in fishing and therefore a decline in economic profit from largemouth bass. The article speculates that a high percentage of hydrilla is necessary for largemouth bass catching.

Florida considers hydrilla a nonnative invasive species that is very difficult to eradicate and control. But, it was observed that if there is no native vegetation was present, hydrilla could be useful in moderate levels. They plan to continue to control the hydrilla levels in order to benefit fish and wildlife.

Brooke Meader, Ryan McGillicuddy

Added December 2014

**Johnson Kevin G., Dotson Jason R., Pouder, William F., Trippel, Nicholas A., Eisenhauer, Robert L. 2014. Effects of hurricane-induced hydrilla reduction on the largemouth bass fishery at two central Florida lakes. Lake and reservoir management. 30(3):217-225.**

This study looked at the effect on both hydrilla and largemouth bass in areas affected by hurricanes. This study mostly focused on fishing competitions and the size and amount of fish the fishermen were able to catch. While this does not directly discuss the hydrilla population outright in this section, there is a correlation between the size and amount of fish in areas with hydrilla versus those that were affected by the hurricanes in Florida in both 2004 and 2007.

Emma Kubik & Julia Wicks

Added December 2014

**Langeland KA. 1996. Hydrilla verticillata “The Perfect Aquatic Weed”. Castanea. 61:293-304.**

Hydrilla verticillata is native to Asia and was discovered in the United States in 1960. Highly specialized growth habit, physiological characteristics and reproduction make life for this plant well adaptable in submersed freshwater environments, such as the Finger Lakes Region. Unfortunately, the plant has spread quickly across the United States and has shown to become a huge problem. So far it has shown to cause substantial economic hardships, interferes with various water uses and has dramatically impacted freshwater habitats.

Although management techniques have been developed, there simply isn’t enough funding to be able to properly control the spread of the plant. Some educational efforts have been places to increase public awareness, however, techniques that are more cost efficient and must be developed for long term management.

Alyssa Vanzo and Vichaka Khoy

Added December 2014

**Li C, Wang B, Ye C, Ba Y. 2014. Ecological Engineering. 70: 268–274**

**(Li c et al. 2014)**

 In this journal it explains and experiment about Hydrilla when added to mew environments can change the whole environment of the water that it is placed in. In this experiment they test total nitrogen and nitrogen decomposition in the water with different amounts of the plant. To test this they took 5 L pails and put 4 L of lake water into the plants. Each bucket had different amounts of the plant into the pals which included 25 g, 12.5, 6.25 g, and 3.125 g of Hydrilla into the buckets and left one normal to test the differences. The plants were left in the water for 70 days for decomposition. At first the plants would make a lot of oxygen and would help the water out. Then with time they would decompose which would just hurt the environment because that would introduce more bacteria and fungi which would produce more nitrogen. Also with time the plant itself would die out in the 70 day period. The Phosphorus levels would also increase greatly in the end of the experiment.

Zackery Zeller & Taylor Byrne

Added December 2014

**Li C, Wang B, Ye C, Ba Y. 2014. The release of nitrogen and phosphorus during the decomposition process of submerged macrophyte (Hydrilla verticillata Royle) with different biomass levels. Ecological Engineering. [ updated 23 March 2014; accessed 6 November 2014]; 70: 268-274. http://www.sciencedirect.com.pluma.sjfc.edu/science/article/pii/S0925857414001773.**

Hydrilla are a vital part of ecosystems. They convert sunlight energy and chemical energy allowing for it to be absorbed by plants. They are a food source to microscopic animals. They are aquatic plants. They work to purify the ecosystem in which they live. The experiment looked at the content of phosphorus and nitrogen in the plants to evaluate the effect of decomposition processes on the ecosystem.

In the experiment, the researchers obtained one type of Hydrilla plant and placed them into buckets. Nitrogen, phosphorus and other plant material was added to the water in the buckets to simulate an aquatic ecosystem. A control treatment without any plant material was also made. They simulated light and dark cycles. They measured a 70 day decomposition process.

They found, based on previous studies, that the decomposition rate of aquatic plants varies with factors such as temperature, aerobic and anaerobic condition, as well as nitrogen and phosphorus conditions in a plant. They found that there is no correlation between the rate of decomposition and the initial biomass level. The decomposition increased total nitrogen and phosphorus levels in the whole environment.

Jordan Johnson, Abbie Reed

Added December 2014

**Michel, A., Arias, R. S., Scheffler, B. E., Duke, S. O., Netherland, M. and Dayan, F. E. 2004. Somatic mutation-mediated evolution of herbicide resistance in the nonindigenous invasive plant hydrilla (*Hydrilla verticillata*). comparative study. [accessed 2014 November 3]; 13: 3229–3237. doi: 10.1111/j.1365-294X.2004.02280.x**

Hydrilla verticillata was brought over to Florida as an invasive species in the 1950’s. In order to combat the issue, fluridone was approved by the USEPA as a systematic chemical control for this plant. Hydrilla apparently built up resistance to the fluridone eventually, leading to the sampling of two-hundred Floridian water bodies; A two to six fold increase in chemical resistance (in 20 of these water bodies) was discovered. It was shown that because of fluridone’s activity as a PDS enzyme inhibitor, mutations at the arginine 304 codon caused plant activity similar to the wild-type but with two to five times less sensitivity to the chemical control. Because of this decreased sensitivity, fluridone resistant Hydrilla verticillata are likely to spread across the nation in the future, posing a significant environmental challenge.
Zach Simolo,Dan Zimmerman
Added December 2014

**Ashutosh Mishra.December 2013.Biosorption of Cr (VI) and Ni (II) onto *Hydrilla verticillata* dried biomass.Volume 73:713-723**

*Hydrilla verticillata* dried biomass was modified by Fenton reagent and its technical feasibility for removal of Cr 6+ and Ni 2+ ions from wastewater were investigated. After biosorption, there was an increase in weight percent Cr 6+ and Ni 2+ ions. The *Hydrilla verticillata* raw dried biomass was compared to the FMB capacity. This lead to the conclusion that the FMB is a better option to remove Cr 6+ and Ni 2+ ions from wastewater instead of the *Hydrilla verticillata*.

In this article, an experiment was done where *Hydrilla verticillata* dried biomass was modified by Fenton reagent, and it was seen how it removed Cr 6+ and Ni 2+ ions from wastewater. Raw *Hydrilla verticillata* biomass and the FMB were put into wastewater, and the reagent was used to see which one would rid of the ions better. It turns out that the FMB worked better in the wastewater than the raw Hydrilla. Also, it was shown that the biosorption process was spontaneous and endothermic in nature.

Cortnee Joslyn

Added December 2014

**Monterroso I, Binimelis R, Rodriguez-Labajos B. 2010. New methods for the analysis of invasion processes: Multi-criteria evaluation of the invasion of Hydrilla verticillata in Guatemala. Journal of Environmental Management (\*\*Edition\*\*) [Internet]. [2010 August 2, cited 2008 April 14] Volume 92, Issue 3. Available from:** [**http://www.sciencedirect.com.pluma.sjfc.edu/science/article/pii/S0301479710003038**](http://www.sciencedirect.com.pluma.sjfc.edu/science/article/pii/S0301479710003038)

A case study was preformed on Lake Izabal, which is a body of water attached to the Caribbean Sea in Northeastern Guatemala. Local fisherman had noticed an alien species in the lake. A few years later, this alien species could be seen around the entire lakeshore. Its name is Hydrilla verticillata and it damages ecosystems, threatens native species, and impacts fishing as well as tourism.

In order to advise a strategy to rid H. verticillata from waters, you must first identify the source in which it is being introduced. Whether it is through contamination from a boats propeller, or from inadequate aquarium disposal these sources need to be addressed. This way you can prevent the spread of H. verticillata into unaffected waters.

Implementing a management strategy is crucial in getting rid of H. verticillata. This strategy must well prepared in the sense that every possible scenario is played out. If you are using treatment natural or chemical all possible implications must be thought out. It would not be beneficial to cause a problem while trying to get rid of another problem. For example, the use of herbicides may affect the nutrient levels, which affects the benthonic organisms.

Humans play a large role in the invasion process of alien species. The introduction of a species may be due to a certain individual or the result of an accidental mishap. Many people are affected and rely on a group of decision makers to create a successful management strategy. Successful management strategies must be controlled so people are held accountable for causing damages. This way companies are not illegally dumping chemicals into lakes trying to get rid of alien species.

Joe Bodine, Lilian Nguyen

Added December 2014

**Monterroso I, Binimelis R, Rodriguez-Labajos B. New methods for analysis of invasion processes: Multi-criteria evaluation of the invasion of Hydrilla verticilliata in Guatemala. Journal of Environmental Management. 2008; 92(3): 494-507.**

This article contains an introduction of hydrilla and what the environmental control issue is. It goes on to discuss the approaching phase and more introduction to the context. This section discusses the impacts, management options, conflicts surrounding the species’, views on various control processes, interviews, workshops, and focus groups all regarding invasive species such as hydrilla. The next section discusses management scenarios for controlling hydrilla, as well as needs and expectations for the control plan. The next section discusses the assessing phase for the plan that was put in place. It evaluates the management scenarios according to criteria, perceptions of social groups, possible compromises, and evaluations of distributional and responsibilities implications. The final section is the conclusions that were drawn from the research and experiments. The article concludes with acknowledgements and references.

This experiment studied how useful it would be to use multi-criteria frameworks to examine local approaches in controlling the invasive species of Hydrilla verticillata. The approach was to use two different groups; one group ages 15-17 and another group of tourist committees. These two groups shared their ideas and came up with ways to raise awareness for the problem. The goal was not necessarily to solve the problem, but educate people on the effects of this invasive species. By raising awareness and educating different groups of people, the topic will gain more support and therefore become a priority for the local government. Although the group did come up with several ways to control Hydrilla verticillata, the first step was to make sure people know about the problem with Hydrilla verticillata in local bodies of water. It was crucial to the study to gain approval of different groups through education and awareness. The developers of this process took into consideration each groups ideas and views on the subject. As a result of this information, a result was concluded on the best way to approach the situation regarding the invasive species.

Jessica Noto, Marissa Stack

Added December 2014

**Mudge CR, Bultemeier BW, Haller WT. 2012. The influence of pH and light on hydrilla (hydrilla verticillata) photosynthesis and chlorophyll after exposure to flumioxazin. Weed Sci 60(1):4-9.**

Flumioxazin is an herbicide and interferes in a plant’s production of chlorophyll. Hydrilla creates weed problems in freshwater. Flumioxazin was proven to be an effective method for treating the hydrilla. Chlorophyll content of hydrilla was shown to decrease as the flumioxazin concentration increased. Plants which were treated with the herbicide decayed typically 1-2 weeks after treatment. Experiments were completed in order to observe the influence of pH on the herbicide’s effect on photosynthesis. It was found that the pH of the water had an impact on the level of control for the hydrilla. Higher water pH encourages rapid regrowth of the hydrilla negating the effects of the flumioxazin. A longer half-life of flumioazin is produced when water is at a lower pH, which increases hydrilla exposure to higher concentrations of the herbicide for longer periods of time. Full sunlight is required for optimal activity of the Flumioxazin.

Brooke Whitman, Jenifer Jimenez

Added December 2014

**Singh A, Kumar CS, Agarwal A. 2011. Phytotoxicity of cadmium and lead in hydrilla verticillata (l.f.) royle. Journal of Phytology. Vol 3(8): 01-04**

The objective of the study was to evaluate the tolerance ability of *H. verticillata* plant to respond to exposure of different concentration of lead (Pb) and cadminum (Cd), common toxic metals found in waste waters or polluted water, by analyzing different biochemical parameters (ex: fresh weight, total chlorophyll, protein, bioaccumulation of heavy metals and NR activity). Two groups of plants were selected from Pond of Plant Science Department, University in India. The first group, the control group, was treated with 10% Hoagland’s solution for 6 weeks during summer. The second group, the selected healthy plants were treated with different concentrations of cadmium chloride solution (a source of Cd) and lead nitrate (a source of lead). It was found that higher concentrations of Pb (20.0 mg/l) and Cd (5.0 mg/l) restrain the plant growth severely, compared to control group. Another reason that explains the reduction in the growth in *H. verticillata* could be the suppression of the elongation growth rate of cells. This is explained by the action of Cd, which causes the proton pump to be irreversibly inhibited. Moreover, the chlorophyll content was observed to be decreased which lead to chlorosis and stunted growth. In conclusion, the experiment showed that toxic levels of Cd cause more damage to *H. verticillata* plants in terms of growth and development, than higher concentration of Pb.

Dina Nykonchuk and Jordan Smith

Added December 2014

**Shearer JF, Jackson MA. 2006. Liquid culturing of microsclerotia of *Mycoleptodiscus terrestris*, a potential biological control agent for the management of hydrilla. Biological control. 38:289-306.**

*Hydrilla verticillata* is a common aquatic weed that has had an overproduction in various water areas. The most common way to get rid of this weed to date is by cultivating the weed out in bunches to reduce its amount so that aquatic areas can still be used for recreation. It is very time consuming, labor intensive, and expensive to continually manage the growth of these weeds in this fashion. It is also possible to control the growth of these weeds with the use of chemical agents however, this could be harmful to other organisms living the same aquatic environment.

The fungus *Mycoleptodicus terrestris* is known for its capability to reduce *Hydrilla verticillata* in aquatic environments in which it is prevalent. *Mycoleptodicus terrestris* produces microsclerotia which can be cultured and used to battle reduce *Hydrilla verticillata* in water. The paper indicates that the microsclerotia can be extracted from the fungus in both wet and dry conditions. This would make it possible to perform the extraction in a laboratory setting and make a liquid culture to introduce into the environment. Due to the fact that the microsclerotia would be extracted from a fungus, this would be a nonchemical agent that is found in nature. In turn, this would mean that other organisms living in the environment wouldn’t be harmed.

Deepika Sivakumar, Nevin Strub

Added December 2014

**Sutton, David L. March 1996. Depletion of turions and tubers of *Hydrilla verticillata* in the North New River Canal, Florida. Aquatic Botany. [accessed 2014 November 7]; 53(1-2):121130.http://www.sciencedirect.com.pluma.sjfc.edu/science/article/pii/0304377095010173**

Samples taken between 1984 and 1995 from the North New River Canal before and after herbicide treatments indicate extreme effectiveness on behalf of the treatment. Grass carp fish were accidentally introduced into the canal around 1989 and they feed on Hydrilla. This, in combination with herbicides, have significantly lowered the Hydrilla population in the area. This approach combined the chemical (herbicides) and biological (carp) approaches. Using two different approaches could minimize negative consequences.

Theresa Clark, Ferhat Kara, Sarah Safura

Added December 2014

**Theel HJ,Nelson LS, Mudge. July 2012. Growth regulating hydrilla and subsequent effects on habitat complexity. Journal of Aquatic Plant Management. 50: 129-135.** [**http://apms.org/wp/wp-content/uploads/2012/01/2-17716-p125-146-APMdj.pdf**](http://apms.org/wp/wp-content/uploads/2012/01/2-17716-p125-146-APMdj.pdf)

Herbicides were sprayed to control the growth of hydrilla. This decreased the hydrilla’s weediness. The decrease in the hydrilla plants led to a habitat complexity beneficial to fish and other aquatic fauna.

Alexandra Brown, Josh Fox

Added December 2014

 **Van TK, Wheeler GS, Center TD. 1999. Competition between Hydrilla verticillata and Vallisneria americana as influenced by soil fertility. Aquatic Botany. 62(4):225-33.**

The Hydrilla is considered to be an invasive plant species in the U.S. whereas the American eelgrass is a native plant species in the U.S. The habitat that plants grow in is commonly known to have a great impact on how well the plant species thrives. High fertility allows the Hydrilla to dominate over the American eelgrass when in the same environment together. It was also found that in low fertility environments, the eelgrass thrived better than the Hydrilla, which could lend us to finding a way to control and/or prevent the Hydrilla invasion.

Both the Hydrilla and the American eelgrass were tested in environments of various fertility levels both together and separate in order to test growth rates and their abilities to compete.

In the growth experiments, each plant was placed, individually, in three different containers for each level of fertilization at levels that were previously used in other experiments. The water was at a flow rate so that the take would be completely replaced every 24 hours. The tanks were also periodically cleaned of any debris or algae growth. After 10 weeks, the plants were harvested and relative growth rates were measured and calculated.

In the competition experiments, similar containers were used, but different amounts of each plant were used per each container. The amounts started from no Hydrilla and all eelgrass per container and the amount of each plant was changed inversely until there was only Hydrilla and no eelgrass. The samples were harvested after 16 weeks and then measured for their above and belowground lengths.

The results showed that the Hydrilla grew significantly better than the eelgrass in the high fertility environment, about 6 times greater. But the eelgrass performed better than the Hydrilla in low fertility environments. This was equally reflected in the competition trials. The Hydrilla was far better than the eelgrass at competing in high fertility environments, but fell short and was beaten out by the eelgrass in low fertility environments.

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**Yu H, Ye C, Song X, Liu J. 2010. Comparative analysis of growth and physio-biochemical responses of Hydrilla Verticillata to different sediments in freshwater microcosms. Ecological Engineering. 36(10):1285-1289.**

**(Yu et al. 2010)**

Shallow lakes in China have seen a large increase in eutrophication from external pollution and thus resulted an oxygen deficiency in some of these lakes. Researches are looking for ways to bring back the lakes to stable conditions. Hydrilla is a plant that can survive in many different types of environments, so it was used as an experimental plant to see if possible future biomass would be able to grow. They would plant the hydrilla in different sediments and then report back to see how well the hydrilla adapted to the environment it was in. Results in sediment showed that the fertile sediment was much better at growing the hydrilla than the brown clay. However both were able to support the life of hydrilla proving that with the help of humans, other aquatic plants can be brought back to the lakes and be sustained.

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