# Earth & Environmental Sciences (900)

<table>
<thead>
<tr>
<th>Project No.</th>
<th>Student(s)</th>
<th>Project Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>901T11</td>
<td>Aryaa Agarwal, Nitya Ganta</td>
<td>The Effect of Stomatal Complex Design and Micromorphological Characteristics on the Optimal Air Filtration Efficiency of Vegetation</td>
</tr>
<tr>
<td>902T12</td>
<td>Ethan Amoh, Aemaan Azhar</td>
<td>The Effect of Azolla cristata on Chlorine Concentrations in Water</td>
</tr>
<tr>
<td>903X12</td>
<td>Marina Ashurkoff</td>
<td>The Effect of Pestalotiiopsis Microspora on Various Household Plastics</td>
</tr>
<tr>
<td>904X11</td>
<td>Molly Bercher</td>
<td>Can extinction caused by climate change be predicted in temperature-dependent sex determination Agamid species</td>
</tr>
<tr>
<td>905T12</td>
<td>Mick Demcsak, Matthew Robbins</td>
<td>Indicators of PFAS</td>
</tr>
<tr>
<td>906X12</td>
<td>Harini Ganabady</td>
<td>The Effect of Cholecalciferol on the Calcium Absorption and Resistance to pH Changes in Protothaca staminea</td>
</tr>
<tr>
<td>907X12</td>
<td>Chirasvi Gowda</td>
<td>The Impact of Environmentally Friendly Detergents on the Environment</td>
</tr>
<tr>
<td>908X12</td>
<td>Lilly Khalkho</td>
<td>The Effect of Types of Compost on Aquatic Oxygen Levels</td>
</tr>
<tr>
<td>909T12</td>
<td>Jillian Kotin, Emily Rapps</td>
<td>The Correlation Between Climate Change and the Spread on Human Disease</td>
</tr>
<tr>
<td>910X12</td>
<td>Declan McQuinn</td>
<td>The Effect of Barley Straw (Hordeum vulgare) on Algae (Chlorella) and Aquatic Plant (Myriophyllum aquaticum) Growth in Freshwater Ecosystems</td>
</tr>
<tr>
<td>911X12</td>
<td>Rohan Mengle</td>
<td>Evaluating the Effect of Microplastics on Humans via Tertiary Consumption by Monitoring its Accumulation in Daphnia</td>
</tr>
<tr>
<td>912X12</td>
<td>Cathryn Mills</td>
<td>An Investigation of The Impact of Hurricane-Driven Fresh Waters on the Photic Level of Amphidinium in Saltwater Marsh Environments</td>
</tr>
<tr>
<td>913X12</td>
<td>Sydney Munsell</td>
<td>Tracking debris deposition from blasting in quarries to the soil composition in South Riding, Virginia</td>
</tr>
<tr>
<td>914T12</td>
<td>Alizeh Murtaza, Ishana Raja</td>
<td>The Effect of Different Variations of Biochar on the pH of Soil and Plant Growth</td>
</tr>
<tr>
<td>916X12</td>
<td>Beatrix Regan</td>
<td>Marine Dinoflagellates and Ocean Temperatures</td>
</tr>
<tr>
<td>917X12</td>
<td>Heather Stuart</td>
<td>The Effect of Photosynthesis Rates on Stabilizing pH in Goose Creek</td>
</tr>
<tr>
<td>918X12</td>
<td>Larina Yu</td>
<td>The Effect of Microplastics on the Growth of Nannochloropsis oculata</td>
</tr>
</tbody>
</table>

Category Student Count: 24
The Effect of Stomatal Complex Design and Micromorphological Characteristics on the Optimal Air Filtration Efficiency of Vegetation

Aryaa Agarwal, Nitya Ganta

Rapid urbanization and industrialization have accelerated energy and fuel consumption, increasing the spread of harmful pollutants in the ambient air quality in cities. This leads to unexpected issues regarding air quality and climate change, raising serious health concerns. The air toxin projections for 2046 - 2055 show the issue will only become more important and life-threatening. Consequently, the focus is increasing on using urban vegetation to degrade air pollutants. Specifically, stomata are pores on the leaf surface that, along with their surrounding complex of cells, dynamically regulate the gas exchange rate between vegetation and the atmosphere. However, this rate is limited by certain stomatal micromorphological characteristics. This novel research looks to study a promising solution, being which stomatal complex design and micromorphological characteristics (stomatal type, shape, size, density, and index, size of fully open apertures, and size of surrounding cells) optimize the air filtration efficiency (NO2, PM10, O3, and CO) of vegetation. Understanding this relationship is essential to optimal filtration designs for the most effective reduction of air toxins. This research demonstrated that pollution levels were significantly different across vegetation locations, meaning stomata do play a significant role in the air pollution absorbance, which vary across locations based on the stomatal micromorphological characteristics. As expected, the control group had the highest pollution concentrations. The stomata of the Prunus laurocerasus and Ilex cornuta had the highest air filtration efficiency. Data collection is currently ongoing and further lab work is being conducted to draw additional conclusions in relation to the stomatal micromorphological designs.


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The Effect of Azolla cristata on Chlorine Concentrations in Water

Ethan Amoh, Aemaan Azhar

Water contamination by chemicals is a major global health issue, with 3 million Americans affected by health violations of disinfection by-products in 2009, according to the CDC. Azolla cristata (duckweed) could be a possible bioremediation solution in resolving this contamination problem. Duckweed is a genus of free-floating, aquatic plants that grow in streams across the world. Recently, scientists have been using it for water treatments because of its ability to absorb contaminants from its environment. For this project, 20 samples containing 0.25, 0.50 and 1.00 mL of chlorine and 40 grams of A. cristata were used. 18 control samples containing 0.25, 0.50 and 1.00 mL of Cl but no A. cristata were also used. The initial free chlorine, total chlorine, and pH were tested. Two days later, the final free Cl, total Cl and pH were tested. On average, approximately 90% of the chlorine was removed from the samples with duckweed, while the controls maintained approximately the same levels of Cl. The average decrease of free chlorine from the 0.50 mL tests was 5 ppm; the average decrease of total chlorine was 10 ppm. Preliminary data suggests that A. cristata may be a viable bioremediator for removing chlorine from water. Data is still being collected.


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The Effect of Pestalotiopsis Microspora on Various Household Plastics

Marina Ashurkoff

The discovery of the fungus Pestalotiopsis microspora’s ability to degrade polyurethane (PU) in 2011 has opened a number of possibilities in dealing with the modern plastic waste problem. This experiment utilized this discovery in conjunction with new research that suggests experimentation with solid bulk polyurethane would provide more applicable environmental results, to propose a modern solution to this issue. Two other plastics, polyethylene terephthalate (PET) and polyethylene (PE), also appear to be promising subjects for degradation using Pestalotiopsis microspora due to their weaker molecular structure and recent research into methods to degrade them. It has been found that Pestalotiopsis microspora was unable to degrade PE in the liquid assay form, but its ability to degrade PE in bulk form remains untested.

This experiment exposed household versions of PU, PET, and PE to Pestalotiopsis microspora in order to investigate Pestalotiopsis microspora’s ability to degrade them in their solid forms. Household versions of the plastics were used due to their ubiquity in the environment. Pestalotiopsis microspora cultures were grown in petri dishes with plastic samples in their respective forms (PU foam, PE Ziplock bags, and PET plastic cups) and dextrose agar medium. Measurements of the plastics’ degradation were taken using weight measurements. The significance of the final results was determined using analysis of variance.


Liu, J., He, J., Xue, R., Xu, B., Qian, X., Xin, F., Blank, L. M., Zhou, J., Wei, R., Dong, W., & J/We hereby certify that the above statements are correct and the information provided in the Abstract is the result of one year’s research. J/We also attest that the above properly reflects my/our own work (digitally signed).
Temperature-dependent sex determination (TSD) is a type of environmental sex determination in which the outside incubation temperature of the egg influences the amount of androgen and estrogen produced in the egg. These hormones determine the sex of the offspring, so a clutch in which more estrogen was produced would result in mostly females. In theory, an increase in temperature in the habitat of the eggs would result in a decrease in population within the next few generations. This experiment compares yearly observations of TSD and GSD (genotypic sex determination) agamid species with the average yearly temperature over 30 years. From the data collected, there was no observable connection between the number of observations and average temperature. However, the data does not account for other factors such as location of eggs, and the reliance on observation data. Rhen, T., Schroeder, A., Sakata, J., Huang, V., & Crews, D. (2011). Segregating variation for temperature-dependent sex determination in a lizard. Heredity, (106), 649-660. 0018-067X/11

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## LCPS RSEF OFFICIAL ABSTRACT - 2022

### Indicators of PFAS

Mick Demcsak, Matthew Robbins

PFAS has recently caused a stir in the scientific community as its effects are not fully known but are speculated to have a negative impact on humans and animals alike. Another obstacle in research of PFAS is how expensive it is to test. In this experiment, multiple locations that have already been tested for PFAS will be tested for other water quality indicators. These indicators include: pH, Nitrate, Nitrite, and Ammonia. These factors will be tested in hopes that they will provide an indication of higher or lower levels of PFAS so that it can be better spotted and save money. Ammonia is the most probable of indicators, as it seems to be present everywhere, even in distilled water.

Basic Information on PFAS. (n.d.). Retrieved October 5, 2021, from [https://www.epa.gov/pfas/basic-information-pfas](https://www.epa.gov/pfas/basic-information-pfas)


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The Effect of Cholecalciferol on the Calcium Absorption and Resistance to pH Changes in Protothaca staminea

Harini Ganabady

Ocean acidification is a prevalent issue that occurs when excess atmospheric CO2 is absorbed by the oceans, decreasing the pH and harming marine life. This research focuses on how one could strengthen the shell of *Protothaca staminea* (littleneck clams), in order to make it more resistant to pH changes. The independent variable is the amount of vitamin D (mL) added to the water. The dependent variable is the percent (%) change in mass of the 60 clams. The control group contains the species with a pH of 7.5 environment, without the vitamin D or calcium. The means of the control group, the experimental group with 0 mL of vitamin D, the experimental group with 2 mL vitamin D, and the experimental group with 4 mL of vitamin D were -0.0588%, 2.1565%, 4.9714 %, and 0.7401%, respectively. An ANOVA test was performed, and the p-value was 0.036519 (less than 0.05), making the results statistically significant. The experimental hypothesis states that if the pH decreases and more vitamin D is put in the water, then the clams will absorb more calcium and resist pH changes for a longer period of time, contributing to a lower percent change in mass. Both the experimental and null hypotheses were rejected. The independent variable influenced the dependent variable. However, the calcium alone affected the percent change in mass more than the addition of vitamin D. Further research could explore if a larger environment could aid in making the results more accurate.


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Many current day so called “environmentally-friendly” detergent brands have been found to be falsely reporting themselves as environmentally-friendly to the public in order to boost their sales. Not only does this create a false sense of euphoria around how truly damaging detergents are to the environment, it overall leads people, who are attempting to be environmentally cautious, to unintentionally damaging the environment. Because of such fraudulent marketing schemes being present in the detergent industry, the relationship between “environmentally friendly” detergents and the environment (pH of soil and worms) is being tested. It was hypothesized that surfactants, or surface active agents, found with the detergents will be toxic to organisms because in a previous study done by AquaTech, an aquatics research nonprofit, it was found that surfactants lead many fish to have an increased rate in the absorption of pesticides and pollutants.

6 “environmentally friendly” laundry detergents will be tested on worms and on the pH of the soil before and after to test the effects of the detergent on the environment. Based on the number of worms found dead in each cup, it will be determined which of the 6 selected “environmentally friendly” detergents are truly environmentally friendly, and by comparing the starting pH and ending pH of the soil, the effect of said “environmentally friendly” detergents had on the pH of the soil will be determined. Each detergent will be tested at 7 different concentrations. Each concentration of each detergent will be mixed into soil and the mixture will be placed into a cup. Each cup will have a certain number of worms placed within them, and based on the number of worms which survive, the detergents which are truly environmentally friendly and which ones are not will be determined. The pH of the soil before mixing in the laundry detergent will be tested, and the pH of the soil after a certain amount of days will be tested to see how the pH was impacted by the detergent.

In conclusion, all of the worms in each detergent tested were found dead after 10 days, regardless of the concentration at which they were being tested at. As the concentration of the detergent within the soil was higher, the worms in the habitat died faster. Although the worms died at the end of 10 days in each concentration, they died at a much faster rate in the higher concentration tests. The pH of the soil became highly acidic after adding in the detergent when compared to the pH of the soil before adding in detergent. The soil with a higher concentration of detergent had a much more acidic pH than that of the soil with a lower concentration of detergent. This could have been one of the likely causes of what led the worms to die at differing rates based on the concentration of detergent which was combined into the I/We hereby certify that the above statements are correct and the information provided in the Abstract is the result of one year’s research. I/We also attest that the above properly reflects my/our own work (digitally signed).
The Effect of Types of Compost on Aquatic Oxygen Levels

Lilly Khalkho

Algal blooms are the rapid growth of algae, which are extremely harmful to aquatic life as they decrease the oxygen in water. This is because of the process of respiration that algal blooms partake in, in order to survive. Algal blooms are created when aquatic systems are exposed to excess amounts of nitrogen and phosphorus because of runoff of fertilizers. Composts are also used frequently and contain amounts of nitrogen and phosphorus, although the amount is exceptionally less. Composts also have the ability to nurture algal blooms, however the type of compost used must be considered as some composts may nurture algal blooms more than others. Aerobic compost and vermicast compost are the two composts tested in this experiment, in order to determine which one impacts oxygen levels the most.

This experiment measured the aquatic oxygen levels with algae before and after the runoff of vermicast and aerobic composts are combined with the river water with algae. Vermicast, aerobic, and normal soil for the control, were soaked in distilled water, while the algae river water settled for 24 hours. The algae river water oxygen levels were measured with an oxygen probe. Next, the vermicast, aerobic, and soil samples of water were combined with algae river water and settled for 7 days. After the 7 days, the oxygen levels were measured with the oxygen probe again, and the final oxygen levels were compared with the initial. This experiment revealed whether aerobic, vermicast, or no compost, will have increased the oxygen levels in the algae river water. Overall, this experiment proves which compost will be most beneficial to the environment, and avoid depleting the aquatic oxygen supply.


Climate change affects the lives of organisms as well as diseases because they need certain environmental conditions to survive (1). Although these diseases can be sustained in a variety of conditions, they have preferences in certain conditions that allow them to thrive. With climate change occurring, it is predicted that the place where some diseases are most prominent and problematic will change (2). This project investigated the effect of human disease spreading due to climate change. Influenza, Cholera, Malaria, Giardia, Rotaviruses, and Cyclosporiasis were individually analyzed based on the environmental conditions needed for survival: such as temperature, humidity, and precipitation (2). This data was then used to predict where the diseases will spread/thrive within the next 100 years.

Once it was determined how each area would change, the diseases were studied to determine their optimum climates, ease of spread, place of origin, and location of greatest human impact. This project focused on the next 100 years. This project's predictions show that there will be a shift in each studied disease's most prominent area as a result of the changing climate. These predictions were overlaid onto a world map created to show each disease's place of origin, current prominent areas, and new predicted hot spots in the next 100 years. These predictions will be useful to leaders who study disease spread so they can plan for these outbreaks.


The Effect of Barley Straw (Hordeum vulgare) on Algae (Chlorella) and Aquatic Plant (Myriophyllum aquaticum) Growth in Freshwater Ecosystems
Declan McQuinn

The eutrophication and subsequent algal blooms in freshwater ecosystems has become more prevalent as human use of synthetic fertilizers has increased. One potential solution to this problem is to utilize barley straw (Hordeum vulgare), which offers a natural alternative to chemical algaecides. This experiment tested whether or not barley straw has an effect on the growth of algae and additionally whether it has an effect on the growth of aquatic plants. Fish bowls with and without barley straw were filled with water collected from a local pond. Chlorella algae and Parrot's feather (Myriophyllum aquaticum) were each grown separately in the fish bowls under a growth light. Using a scale, the wet biomass of the parrot's feather was measured over time and using a hemocytometer, the cell count of Chlorella was estimated. After 21 days, it was found that barley straw did not significantly impact the growth of the aquatic plant as the final biomass with barley straw was 6.53 grams up from 4.75 grams at the start and the final biomass without barley straw was 6.43 grams up from 4.6 grams at the start. After 13 days, the cell count of Chlorella ($10^9$) with barley straw was 1.8 and without barley straw was 3.6 with both starting at $1.28 \times 10^9$ cells. The hypothesis that barley straw would decrease the growth rate of algae while not affecting plant growth rate was supported. Further research could repeat this experiment with many more trials and concentrated Chlorella for more precise results.


Evaluating the Effect of Microplastics on Humans via Tertiary Consumption by Monitoring its Accumulation in Daphnia

Rohan Mengle

Every year, there are over 180 tons of plastic waste produced around the world. (Staton, 2022) Of all the plastic waste, the larger pieces eventually deteriorate into small and undetectable particles known as microplastics. Not only have microplastics been found to accumulate within aquatic organisms, but research shows they are ingested by fish at a rate of 26%, a statistic that has doubled within the last decade and increasing at a rate of 2.4 ± 0.4% per year. (Savoca, McInturf & Hazen, 2021) Researchers now think microplastics are bioaccumulating in the aquatic food chain and eventually reaching humans via tertiary consumption.

In order to quantify the effect of microplastics on humans, daphnia pulex were fed polystyrene based microplastics over the course of several weeks. The experimental daphnia, the ones that received the microplastic treatment, were compared to the group that did not receive any microplastics. By observing the gastrointestinal tract of both groups, results were collected. The results show microplastics not only accumulated within the daphnia in the experimental group, but the accumulation also increased over time.

By using collected data on microplastic bioaccumulation over time, a future endeavor will be to create a time series forecasting algorithm to quantify microplastics reaching humans via tertiary consumption. Additionally, the algorithm will account for the food chain’s unpredictability and utilize data from other relevant research. This algorithm aims to quantify the amount of microplastics that reach humans via food consumption.


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An Investigation of The Impact of Hurricane-Driven Fresh Waters on the Photic Level of Amphidinium in Saltwater Marsh Environments

Cathryn Mills

Amphidinium cartaeae, a type of dinoflagellate marine protist, thrives in saltwater environments. However, extensive hurricane rainfall contributes to their optimal habitats being compromised. The purpose of this research was to investigate how Amphidinium cartaeae react to freshwater (simulating hurricane rain) infiltrating a small-scale environment and observe their adaptations. Amphidinium were added to 200 milliliters of seawater medium. A valve was opened to release 200 milliliters of springwater into the container. Photos taken periodically were analyzed in ImageJ to determine how many Amphidinium were located at each spatial level: top, middle, and bottom. A control group in which 200 milliliters of saltwater was poured instead of the springwater was also photographed and analyzed for comparison. It was hypothesized that the Amphidinium would swim towards the bottom of the container, the saltiest area. Statistical analysis via t-test indicated a significant difference in the percentage of Amphidinium in the bottom and top levels of the container with freshwater infiltration versus the control, in which all saltwater was added to the container. As freshwater infiltrated the test chamber, a greater percentage of Amphidinium oriented themselves at the bottom where greater concentrations of saltwater existed. The study of the effects of freshwater infiltration into marine habitats such as saltmarshes merits continued research. If saltwater organisms, which exist at the bottom of the food chain, are driven downward due to freshwater infiltration, possible food chain collapses could occur, affecting other organisms in these habitats that depend on them as a food source.


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Tracking debris deposition from blasting in quarries to the soil composition in South Riding, Virginia

Sydney Munsell

Debris released into the atmosphere from quarries could result in contamination of the surrounding environment. South Riding, Virginia is underlain by rocks of the Culpeper basin, mainly consisting of basalt, which is partly composed of potassium oxide. Therefore, a potassium indicator was selected to analyze the composition of the surrounding soil in order to evaluate the environmental effects of the debris from quarries. Samples were taken on a linear plot between two quarries in South Riding, Virginia, including sediment cores that were tested chemically and a digital test to collect data on the potassium levels in the soil. The data from the digital test shows a trend of increasing potassium levels near the quarries, with the lowest levels being recorded near the midpoint.


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The Effect of Different Variations of Biochar on the pH of Soil and Plant Growth
Alizeh Murtaza, Ishana Raja

To amend acidic soil, a trait detrimental to the health of crops, scientists have begun to employ the use of biochar- the charcoal residue left over when biological material is burned. It is a fine-grain, porous, and carbon-rich material, garnering attention from researchers and farmers alike. There has been a significant amount of research done on biochar and its effect on soil and plant growth. However, not much is done on the different types of biochar and if they affect soil in different ways.

To find if there is a difference, biochar made from wheat straw, corn husk, and peanut husk was tested on soil and observed to see the effects on pH and germination rates of Brassica rapa plants.

There was a significant difference between the control and experimental soils; the p-value was 2.69E-39. Between the different types of biochar and control, the t stat for peanut husk was -36.5, wheat straw was -38.5, and corn husk was -35.924. There was a net increase in pH in the experimental groups and they varied between the groups. However, there was no significant data in terms of plant growth with a p-value of 0.249.

To further research, other types of biochar could be used and tested on, multiple trials for the control can be implemented, and the experiment could be run for a longer period of time.

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The Process of Inhibiting Cyanobacteria Formation in Natural Water Bodies by the Effects of Algae Removal and Prevention Methods.

Jeehyun Jeon, Mayukha Rajupalepu

After the events at the Shenandoah River in the summer of 2021, where cyanobacteria caused toxic algal blooms to the water and dangerous levels of acidity, this experiment was designed to find a method of preventing the growth of toxic cyanobacteria in affected areas globally. From the research conducted prior to the start of the experiment, findings showed that cyanobacteria tends to thrive naturally in areas of high acidity. Furthermore, one of the potent chemicals present in the water with the presence of cyanobacteria was phosphorus. This experiment was designed to formulate a method of reducing the amount of phosphate levels and acidity of the affected water with both natural and non-natural methods. This experiment used the non-natural methods of Copper sulfate and Hydrogen peroxide as well as the natural methods of Cinnamon and Barley Straw extract, all chosen for the low level of harmfulness when added to water bodies. The procedures of this experiment included obtaining initial pH and dissolved phosphorus levels of both the Potomac water and Shenandoah water samples used in the experiment, before and after the addition of specified bacteria samples: Nostocales and Oscillatoria. The chosen bacteria samples were used for their durability and adaptability. After adding the bacteria samples to the water, the experiment was repeated with either the natural or non-natural preventative and pH and dissolved phosphorus level results were taken. The experiment’s findings were that the Barley Straw extract had the greatest positive effect on reducing the acidity of the water, while Cinnamon had the most positive effect on the dissolved phosphorus levels.


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The purpose of this experiment was to understand the effect of temperature on marine dinoflagellates. Zooxanthellae, a type of dinoflagellate, are present in hard corals and have been linked to bleaching when exposed to increased ocean temperatures. This experiment was conducted in order to determine the extent of the damage done to dinoflagellates when placed in warm environments. Marine dinoflagellates were placed in temperature-controlled environments for 48 hours. The average coral reef temperature control of 26°C was compared to 30°C (bleaching temperature) and 32°C. At the start of the experiment, the average count of dinoflagellates per 0.00625 cubic mm was 23.2. While the control group remained at an average count of 22.3, both experimental groups dropped down to average counts of 14.3 and 12.0 respectively. According to t-test data, the hypothesis was not supported by the data. This is likely due to a lack of replicants, as the data shows promising differences. The experiment should be replicated with more samples. Further research could explore the significance of dinoflagellate death within corals when temperatures are raised, as well as methods to reduce dinoflagellate death under higher temperatures. The solution to the prevention and restoration of bleached ocean corals may be found in dinoflagellate preservation.


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The Effect of Photosynthesis Rates on Stabilizing pH in Goose Creek

Heather Stuart

With increased pollution rates and the burning of fossil fuels releasing CO2 and SO2, the rate of freshwater acidification over the years has increased tremendously. Plants have been found to act as a buffer for the acidification process in freshwater systems. However, there is little existing evidence to support that photosynthetic rates have an effect on the acidification process by serving as a buffer.

This study analyzes and determines whether or not the photosynthetic rate affects how much of an impact plants have on freshwater acidification. Plants with different photosynthetic rates will be placed into collection containers with varying pH levels and containing three hundred milliliters of freshwater from Goose Creek in Leesburg, Virginia. Data will be collected from twelve collection containers: three with only creek water, three with the Elerya densa plant, three with the Vallisneria americana plant, and three with the Nymphaeaceae plant. Each beaker will have its pH and dissolved oxygen levels tested once every seven days and data will be recorded to determine which plant provided the best buffering system for the freshwater sample. Data shows that Elerya densa best stabilized pH levels but that the
The Effect of Microplastics on the Growth of Nannochloropsis oculata

Larina Yu

With increased plastic use, the effect of plastic pollution on marine environments has become increasingly pertinent. The objective of this experiment was to evaluate the risk posed to Nannochloropsis oculata microalgae by microplastics (MP). The study consisted of three groups of N. oculata: control, MP, and UV-treated MP (UV-MP). All groups were grown at 25°C in 3% artificial seawater under a 12/12 light/dark cycle. PET plastic was shredded and half was exposed to 365 nm UV rays for ~1.5 hours, before being added at 1 mg/mL concentration to the MP and UV-MP groups. Each group’s absorbance was measured regularly at 420 nm over a 2-week period.

Preliminary results indicate the UV-MP group was severely stunted. In two weeks, the UV-MP’s change in absorbance was only half that of the control’s. The MP group was also stunted, but not to as significant a degree. This difference shows that UV-radiation can significantly exacerbate the effect of MP on microalgae. As UV-radiated MPs match environmental conditions more than pure MPs do, the risk of plastic pollution to microalgae could be greater than previously indicated. Future research should focus on evaluating the impact of plastic pollution while under environmental conditions. Overall, it seems that measures need to be taken regarding the protection of N. oculata, an important primary producer, from plastic pollution.


Wen Yi Chia, Doris Ying Ying Tang, Kuan Shiong Khoo, Andrew Ng Kay Lup, Kit Wayne Chew, Nature’s fight against plastic pollution: Algae for plastic biodegradation and bioplastics