

**FOURTEENTH ANNUAL
STUDENT RESEARCH
POSTER SYMPOSIUM**

**MAY 14, 2010
1PM - 4PM**

HOLT HALL

**DEPARTMENT OF BIOLOGICAL SCIENCES
CALIFORNIA STATE UNIVERSITY, CHICO**

POSTERS

LOWER DIVISION CLASSES

Holt 227

UPPER DIVISION CLASSES, UNDERGRADUATE RESEARCH, GRADUATE CLASSES

Holt 225

GRADUATE RESEARCH

Holt 235

ENTOMOLOGY CLASS DISPLAY

Holt 235

HERBARIUM OPEN HOUSE & PHOTO CONTEST

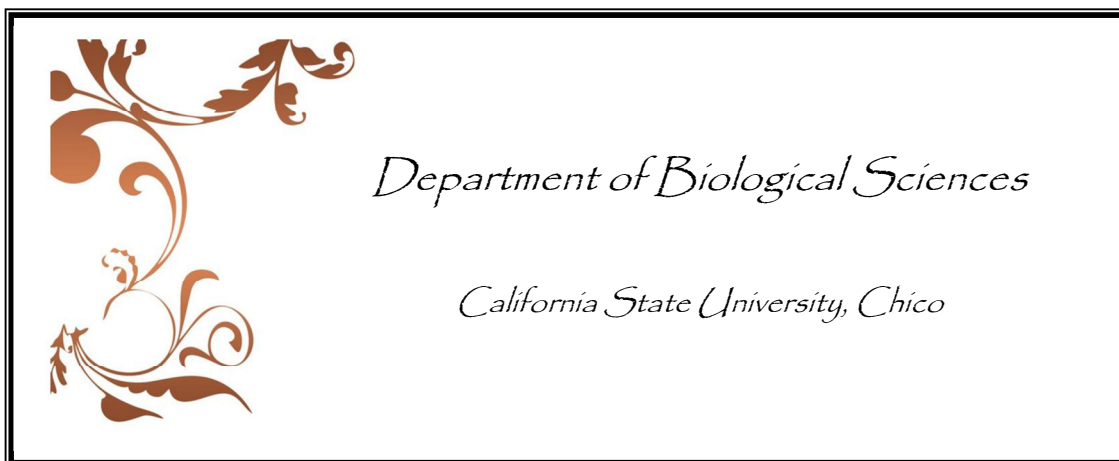
Holt 129 - 131

1pm – 3 pm

Department Awards Seminar

Holt 170

4pm



Recipients of the Tom Rodgers
Outstanding Researcher Award

1997 Ronald E. Loggins

1998 Maura Eagan

1999 Moaiad A. Kanaan

2000 Carina M. Jung

2001 Cary Coburn

2003 Glen Lubke, Jack Campbell, Gary Lechner

2003 Julia Terry

2004 Colleen Martin, Michelle Sopoliga, Michelle Ocken

2005 Alan Raetz

2006 Khang V. Do, Chris L. Clifford

2007 Adam M. Ferris

2008 Nicole J. Huber

2009 Akiko Masuda

Lower Division Class Projects

Comparison of C3 and C4 Rate of $O_2/\text{min}/\text{cm}^2$ between *Coleus blumei* and Corn (*Zea mays*)

Julie Lengerich Juliep_9390@yahoo.com, Michael Snow Imgone04@gmail.com

BIOL 151: Darhl Whitlock

The alternative hypothesis for this experiment is that C3 will produce a higher oxygen concentration per minute per centimeter squared than C4. This experiment compared C3 and C4 photosynthesis of *Coleus Blumei* and *Zea Mays* to test the rate of O_2 production. The experiment was conducted to see if there was a difference between the C3 and C4 photosynthetic pathways. To accomplish this, The Qubit system and the Logger pro software to evaluate the $O_2/\text{min}/\text{cm}^2$. which removes all oxygen from the chamber containing the leaf and fills it with carbon dioxide, a sensor then detects the production of oxygen. The results from the experiment yielded a mean value of $.247 O_2/\text{min}/\text{cm}^2$ for *C. blumei* and $.441 O_2/\text{min}/\text{cm}^2$ for *Z. mays*. Based on the two mean values it can be conclude that *Z. mays* have a higher $O_2/\text{min}/\text{cm}^2$ production. The critical T value is 2.10 at a P-value of .05 with 18 degrees of freedom. The calculated T value from the experiment was 4.58. This suggests that there was a difference in the $O_2/\text{min}/\text{cm}^2$ between the two plants and we can reject our null hypothesis.

Ecological study of brassica

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BIOL 152: Michael Marchetti

The heat, water logging, and the variation in pollination have effect in germinating, and flowering in the brassica Rapa. In this experiment am going to know if the different in withering can effect in germinating and flowering in the brassica Rapa. In other hand, to know how many seed will germinate and how long the plants take time for flowering; in sequence, will know which of the 60 seeds will germinate and flowering the water logging, heat, and the variation in pollination have a great effect in the germinating the seed and flowering in the brassica Rapa. I took 30 Receptacle and 60 seeds from fast plant from the second germination (offspring) that we had done in lab. Next, putting 10 receptacles in the atmosphere, the second 10recptacle in closed lighting and watering but the temperature more than 27 Celsius, and the third 10 receptacle, I put it in the room watering, and lighting that most required to germinated and flowering in same period of time. The result I rejected my null hypothesis the heat, water logging, and the variation in pollination have no effect in germinating, and flowering in the brassica Rapa. 50 seeds are germinated and just 30 are flowering from the 50, so the plants who was in the atmosphere did not grow fast as expected, also the one in the room temp more than 27 Celsius 5 of them germinated and they stop growing up, but the last one in the room with good observations in watering and lighting germinated well and flowering and they had perfect photosynthesis.

Physiognomy & Stomata

Jessica Acton, Susan Lee, Carrie Vang

BIOL 152: Michael Marchetti

Earlier this semester in biology 152, lab section 06, we did a short experiment on stomatas. The experiment was to test whether sunlight affected the stomatas densities. Using that concept, we conducted an experiment of our own. Our hypothesis was if physiognomy determines the stomatas densities and to do so, we went to Upper Bidwell Park and collected 3 samples of trees leaves (tall) and shrub leaves (short). The conclusion we came to was that growth did affect the number of

stomatas. In the majority of our tree leaves, the average number of stomatas was significantly higher than that of shrub leaves. However we do have to take into consideration the type of species that were chosen.

The Effects of Water Availability on Photosynthesis

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BIOL 152: Joel Mintzes

Stomatal density of leaves is one factor that plays a role in regulating the rate of photosynthesis in plants. The objective of this experiment was to discover whether proximity to a water source affects the stomatal density, and therefore photosynthetic rate in *Hedera hibernica*. Leaves from this species of English Ivy were sampled at various distances from Big Chico Creek and stomatal density was analyzed. The calculated T-value was 3.77 compared to a T-critical of 2.57, ($p < 0.05$). These results indicate that stomatal density of plants near a water source is significantly higher than plants at a further distance from a water source. We concluded that we can reject our null hypothesis, which stated that distance from a water source has no effect on stomatal density.

The Stomatal Density of California Buckeyes (*Aesculus Californica*)

Kara Babo (kbabo@mail.csuchico.edu), Andre Bossieux, Nicole Olberding, Ashli Robertson

BIOL 152: Christopher Ivey

The motivation of the experiment was to find out if the amount of stomatal density differed with the amount of CO₂ in the environment, and how the CO₂ affected the trees. The problem under investigation is that the *A. Californica* would have more stomatal density near Esplanade, a street with high carbon emissions, than a tree of the same species in a low carbon abundance location, because the plants would benefit more with more stomata in a CO₂ rich environment. The study was conducted by picking samples, of leaves from a tree near Esplanade and a tree in the middle of Chico State's campus, and counting the stomata of each. Statistical tests, such as the T-test, with a P-value of 0.05 and a T-critical number of 2.23, found that there was no significant difference in the amount of stomata between the two trees in the experiment. These results mean that the level of CO₂ around the trees does not affect them as long as the CO₂ levels stay constant.

***Linepithema numile* and Calorie consumption**

Carey Bruns, Leslie Calzada, Kimberlee Fong, Michelle Pritchard, Sydney Scheeler

BIOL 152: Tag Engstrom

Through this experiment, upon observing the species *Linepithema numile* (an invasive Argentinean ant), we determined the statistical difference in comparing the time that is taken for them to consume either a high or a low calorie food item. Each of the two items, Peanuts and Cheerios, were crushed and placed for statistical analysis. It highlighted the significant difference between the rates of calories, per hour in the of food products consumed. Individual ants of *Linepithema numile*, were observed and colonies were located. At each colony, we compared the number of calories absorbed per hour by the subjects, testing for a significant difference in calories/hour as well as which food product was favored, calorie dense peanuts or less calorie dense cheerios. The results proved an insignificant difference between the two rates (calories/hour) of peanuts and cheerios consumed. Consequently, with a t-calc of 0.928 and a t-crit of 2.45, $t\text{-calc} < t\text{-crit}$, a degrees of freedom=6 and P value=.05 we can therefore not reject the null hypothesis.

Pollutant Absorbency and the Affects on pH of Different Soil Types in Bidwell Park

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BIOL 152: Michael Marchetti

Our motivation behind this project spurred from our desire to be environmentally responsible. As Environmental Science majors (and local Chicoians) we feel it's our responsibility to help preserve the quality of Bidwell Park, whether by studying the effects of common pollutants on soil or by sharing our data. Soil quality affects all facets of life and even trace amounts of pollutants can contaminate acres of land. Pollutants can enter ecosystems and food chains via the soil, increasing in toxicity through bioaccumulation. To determine a pollutant's potential, six different soil types were collected in Bidwell Park and analyzed for their ability to absorb ammonia, Round Up and motor oil. The pH level of each contaminated soil sample was also recorded. Using Microsoft Excel, an ANOVA test was conducted, yielding a p-value of $2.5E^{-6}$, suggesting a correlation between different pollutants and soil pH. We concluded that although the pH changed with the pollutants, there was little change between the different soils despite their different characteristics and qualities. The soil absorbency was consistent with our first hypothesis, that soils which were more saturated would absorb less of the pollutants. Our data also supported our second hypothesis that the thicker the consistency of the pollutant, the less it would be absorbed. Therefore, it is important to keep pollutants away from the soil because they can contaminate ecosystems such Bidwell Park. These pollutants seep into the soil and degrade the fertility and affect all trophic levels.

Nurse Trees in Bidwell Park

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BIOL 152: Don Miller

The main problem we investigated is whether there is evidence to support the theory that nurse trees exist in Bidwell Park. Our motivation for this experiment rose because although there is an abundance of research collected in foreign countries, there is a lack of American research on nurse trees. For our assessment, we focused on the relationship between Blue Oak trees (*Quercus douglasii*) and Poison Oak plants (*Toxicodendron diversilobum*). Our first hypothesis was that *Quercus douglasii* serve as nurse trees for the *Toxicodendron diversilobum*. Our second hypothesis was that the number of *Toxicodendron diversilobum* plants surrounding the *Quercus douglasii* would be proportional to the height of the *Quercus douglasii*. Our reasoning suggests the taller the *Quercus douglasii*, the more shade it will produce and therefore more *Toxicodendron diversilobum* will sprout. Our third hypothesis was that our results would be consistent with other studies, producing evidence of the existence of nurse trees in Bidwell Park. Over several days, our group measured the heights of numerous *Quercus douglasii*, as well as the quantity and heights of surrounding *Toxicodendron diversilobum*. Our results support our first hypothesis, but no direct correlation was found between the *Quercus douglasii* height and the number of *Toxicodendron diversilobum* plants. However, it was found that nearly 100% of the *Toxicodendron diversilobum* grew to the East of the *Quercus douglasii*. The consequences of these findings raise questions like whether *Toxicodendron diversilobum* are dependent on *Quercus douglasii* in other locations, and paves way for future research on nurse trees.

The Influence of Music on Plant Growth

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BIOL 152: Christopher Ivey

The study of plants is the keystone of biology. There have been many experiments performed on plants to see if music has any effect on such organisms. In this work we have chosen four different herbaceous plants and three different types of musical treatments. Using catnip, chives, tarragon and thyme in controlled combination with the musical selections of Frédéric Chopin, Little Wayne and the absence of music, we will attempt to discern the effects these various sounds have on plant growth. After four weeks of careful application of said musical treatments to newly germinated seeds, it has been concluded that plants exposed to the musical styling of Chopin were more voluminous and taller than plants with no music at all and the plants exposed to the rapper, Little Wayne expressed less growth and declined health in relation to the other groups. Similar experiments are often perceived to lack scientific merit for they are hard to recreate and predict their experimental results time and time again. However, it is a very curious experiment and raises many thoughts that concern plant life and perhaps all life in general.

The Density of Local Acorn Woodpecking Trees Related To The Distance From Nearest Refuge

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Rapier (grapier@mail.csuchico.edu)

BIOL 152: Christopher Ivey

Woodpecker's have the tendency to store their food in granaries. These granaries are densely populated in some trees but are completely absent in others nearby. Because woodpeckers must constantly stay alert to avoid predation from hawks and other predators; we designed an experiment to determine if granary density correlates with the availability to nearby cover. We measured the granary density in Bidwell Park, by measuring the distance from the lower-most granary to the ground and compared that value to the distance from the tree to the three nearest sources of cover. During the course of our experiment, we found that all of the visible granaries were located on Oak trees. A t-test of our data proved that our P-value (0.428659) which enabled us to accept our null hypothesis. Because of this, it is safe to conclude that there is no direct relationship between granaries and the surrounding cover trees. However, granaries are only located when there are trees nearby.

A Study of Artificial Selection in *Brassica rapa*

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BIOL 152: Michael Marchetti

In this experiment we studied the effects of artificial selection of trichome frequency in *Brassica rapa*. These techniques are an important tool for cultivating more sustainable crops. Through artificial selection, we hypothesized that trichome frequency mean value would decrease from one generation to the next. We attempted to accomplish this by selecting and fertilizing parent plants with values lower than our determined threshold frequency. The first generation had a mean value of 12.9 trichomes, the second had 9.7 and the third was 2.88. According to the ANOVA, the three values were significantly different with a p-value of 0.00007, which is much smaller than the significance level of 0.05. Over three generations we were able to decrease the trichome frequency mean value between the first and second node of the plant

The Comparison of Stomatal density in *Liquidambar styraciflua* between Chico and Redding

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BIOL 152: Christopher Ivey

The Liquidambar styraciflua (American Sweetgum) has populations within the boundaries of both Chico CA as well as Redding CA. These locations were chosen because they are separated by a distance of approximately seventy miles and have slightly different weather patterns. The stomatal density of L. styraciflua in Redding may be lower than in Chico due to an increased heat intensity present within Redding. Ten leaves total were taken from each tree, five from the inner regions of the tree and five from the outer. The total estimated number of stomata was based on the number of stomata seen within 400X divided by .12mm². When placed into an ANOVA test the P-value was <0.05 at 0.005 thus showing there is significance in the variation of the plants. Overall the mean of the two samples from Chico were greater than that of Redding.

Environmentally Friendly Cleanup of Oil Spills

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BIOL 152: Tag Engstrom

The recent oil spill in the Gulf of Mexico has opened many eyes to the environmental, economic, and social repercussions associated with the use of petroleum based fuels. The danger of the spill in the Gulf has been magnified by the difficulty to clean without further negatively affecting the environment. Scientists from NASA have been using the renewable resource of hair in order to effectively remove oil since 1995 (Walton, 1998). From research we found that both human and dog hair have been used to absorb oil. Our question was to determine which material; human hair, dog hair, or paper towel is more effective in cleaning up oil spills. Our null hypothesis is that there is no significant difference in absorption of oil among dog hair, human hair, and paper towels. Our alternative hypothesis is that there is a significant difference in the absorption of oil among dog hair, human hair, and paper towels. Paper towels were used in this experiment as a less environmentally friendly comparative. Each of the materials were pre-weighed to 5.00 grams and then saturated completely with motor oil. The mass of each material, including oil, was then post weighed to obtain a mass. The procedure was repeated three times for each material and average masses of oil were obtained. The average mass for human hair, dog hair, and paper towels were 23.07 grams, 25.50 grams, and 17.18 grams respectively. An ANOVA analysis was used to determine an F-Crit of 5.14 and P-value of 0.058 at 8 degrees of freedom. Based on a P-value that is greater than 0.05, we fail to reject our null hypothesis. There is no significant difference in the absorption capability of human hair, dog hair, and paper towels. These results support the effort to use renewable resources when addressing oil spills. There is no benefit to using a costly resource like paper when human and dog hair mats can be used just as effectively while also being wrung out and reused. The ability of hair to be wrung out also allows for oil to be recovered and purified for future use, a huge benefit to oil companies (Walton, 1998).

Comparison of bacterial cultures in examining the notion of a "human corporal ecological gradient"

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BIOL 152: Christopher Ivey

Ecological gradients, in which subtle and minor variations in an otherwise uniform habitat can result in differences in biological diversity, are a well-known and well-supported phenomenon. Differences

in the amount of light an area of the human body receives, moisture found in that area, etc. could possibly cause the creation of microenvironments of bacteria in an ecological gradient. If proven true, this could have numerous implications, especially in the area of medicine and treatment of dermatological conditions caused by bacteria, as well as treatment of diseases introduced into the body via the epidermis. The hypothesis that the moist back of the knee (which typically receives less light and less frequent washing than the forearm) would be host to more bacteria was tested by growing cultures from these contrasting areas of the body. The bacterial flora was compared by gross inspection of the colonies formed. With a p-value of 0.212, the null hypothesis that there is a statistically significant difference in amount of colonies formed could not be rejected.

Bird selection of Habitat: Riparian vs. Urban

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BIOL 152: Christopher Ivey

We examined the diversity and species richness of two settings: Riparian (Big Chico Creek) and Urban (Chico State Campus around Legion Ave and Mansion Ave). A total number of 15 species were counted, totaling 106 individuals. We found the sparrows and the Starling to be the common species throughout the study (sparrows =43, Starling=25). Based off this information we calculated Shannon indices, and found that Big Chico Creek had a higher diversity ($\bar{X}=1.4256$) than the urban setting ($\bar{X}=0.71297$). Big Chico Creek also had a higher species richness, 8 species, than the urban setting with 7 species. However, when we preformed a t-test we found that it was by chance that the riparian area had a higher diversity and species richness than the urban setting ($t=1.524$, $df=7$, $p\text{-value}=0.05$).

Did All Marsupials Originate From Australia?

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BIOL 152: Michael Marchetti

Marsupials are commonly associated with Australia for that is where the majority of marsupial diversity is located. We wanted to investigate why this disparity exists. Is it because marsupials originated in Australia or is it due to other factors? Using Gen Bank and MEGA 4, we were able to collect DNA sequences and create a phylogenetic tree displaying the evolutionary relationships between different taxa of marsupials from the Americas and Australia, including its surrounding islands. After constructing our phylogenetic tree, we were able to observe an obvious branching between the American and Australian marsupials which occurred early on in evolutionary time. Due to the configuration of our tree, it was evident that marsupials did disperse from Australia, which led us to surmise that marsupials did not originate from Australia alone.

Phylogeny of Dendrobates

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BIOL 152: Michael Marchetti

By obtaining genetic sequences of 15 taxa of Dendrobates from the Biology 152 lab resource page and constructing a phylogenetic tree with Mega 4, we found the species *D. ventrimaculatus* to be polyphyletic whereas it's classification suggests it to be monophyletic. This contradiction lead us to investigate the similarities among sister clades. The consequences of these results suggest that the classification of *D. ventrimaculatus* was most likely based on phenotypic or morphological differences instead of genetic differences.

Comparison of Fast Plant growth between Gatorade and Water

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BIOL 152: Don Miller

The goal of this project was to estimate whether the sports drink Gatorade would have a growth benefit on plants due to its electrolytes, especially potassium and phosphates, since they are essential for metabolism in humans and plants. We attempted to evaluate this benefit by equally dividing 24 pots of *Brassica rapa*, also known as "Fast Plants", growing them in a Cool Blue Gatorade medium and a control set using distilled water. Our hypothesis was that the plants grown in the Gatorade solution would be taller than our control plants after four weeks of growth. Using a one-tailed t-test, we failed to show that Gatorade provided a growth benefit over water ($t=17.26$, $df=22$, $p<.0001$). We concluded that Gatorade does not provide a good growth medium for plants, however further testing of the individual ingredients may be warranted, based on observed effects.

Ecological Gradient Analysis within Himalayan Blackberry Bushes

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BIOL 152: Tag Engstrom

The motivation for the project was to measure the biological diversity of "terrestrial insect communities across gradient adjacent sites." (CSUC) The sites that we used were the Himalayan Blackberry (*Rubus armeniacus*) bushes, ecotone, and grassland habitats. We decided to analyze these habitats because according to Friends of Bidwell Park, the Himalayan Blackberries are one of the invasive species plaguing Lower Bidwell Park. It also states that invasive species "out-compete other native plant species, resulting in reduced biodiversity and usually fail to provide requirements for diverse native wildlife species." (Dittes) We hypothesized that the grassland habitat would have a higher Shannon Diversity Index thus having greater biodiversity. We conducted the study by placing five pitfall cups in the ground in each of the different habitats thus allowing us to collect fifteen different samples of insect communities. In our results we found that the Blackberry bush had the lowest diversity, 6.02, while the grass had the highest diversity, 7.82. Our hypothesis was corrected that the grass would have a higher diversity than the Blackberry bush. The most abundant species was the Malacostracan, more commonly known as Roly-poly's. The native plants have more biodiversity than the invasive species, Himalayan Blackberry's, proving that they do not contribute to more biodiversity in Lower Bidwell Park.

Handedness and the False Bird

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BIOL 152: Christopher Ivey

Although there have been studies concerning handedness, to my knowledge the significance of the false bird hand position has not been the subject of any of them. The false bird is similar to flipping the bird except the ring, not the middle, finger is used. Specifically the ring finger is completely straight up from the palm and the other three finger tips are pointed down (not out). My alternate hypothesis is that if someone is able to perform the manipulation, they will be able to do so with their non-dominant hand. The null hypothesis is that people who can perform the manipulation will be able to do so with their dominant hand or with both hands. I surveyed over one thousand people, mostly high school students, to determine the validity of my hypotheses. A chi squared analysis showed that I could reject my null hypothesis with a less than 0.001 probability that it is correct.

Since there have been know previous studies directly related to this hand manipulation, the specific significance of the ability or lack thereof is unknown. Further study across many fields (like: biology, psychology, and neurology) would be necessary to determine what, if any, significance can be attributed to the ability to flip the false bird.

Analysis of Biodiversity of Ecotomes bound by concrete

Nick Krupin (mckrupin@me.com), Ashley Kelley, Frank Rebelo, Brian Parker
BIOL 152: Tag Engstrom

This experiment was conducted to analyze species diversity between a continuous ecotome and an “isolated” ecotome. Locations would be qualified as isolated if the ecotome is surrounded on all sides by concrete. This will provide us information on the importance of habitat connectivity in association with species diversity. Our study consisted of placing several pitfall traps in two different areas (grass and open). These pitfalls were filled with a soapy solution. The purpose of this was to prevent the captured animals from escaping. The traps would be collected after 5 days. Our hypothesis is that the isolated environments will support a lower species diversity than the continuous environments.

Effects of varying salt concentrations on *Thymus x citriodorus*.

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BIOL 152: Don Miller

With current agricultural practices that are slowly increasing salt concentrations in soil and water, our goal was to identify if this increase would effect the growth of *Thymus x citriodorus*, a plant grown in California, by measuring the height of three separate plants over the course of ten days. Each plant was treated with different amounts of salt concentrations in 237mL of water that the plants received daily throughout the duration of the experiment. One plant had no salt added (control), one had 5mL of salt added and the last plant had 15mL of salt added. The final results depicted that the two plants with the salt added to the water wilted greatly whereas the control plant grew to a healthy height of 17cm. The 5mL of salt sample was only 5cm high at the end of our experiment which was similar to the 15mL of salt sample at 6cm in height. Through the use of an ANOVA test we were able to identify that there was a large amount of variance of height between the control plant and the plants that had salt added to them. Having an F-crit of 3.40 compared with an F value of 16.09 suggests that our alternate hypothesis is correct and salt does have an effect on *Thymus x citriodorus*. And, since our p-value of 3.69×10^{-5} is so miniscule we can reject our null hypothesis that salt does not have an effect on *Thymus x citriodorus*.

Arthropod diversity differences along an urban gradient

Melissa Maney (mmaney@csuchico.edu)
BIOL 152: Tag Engstrom

Urbanization is becoming a larger concern as the world population goes up, and the delicate balance of arthropod diversity is likely to be effected by it. Controlled yards of homes in which insects are kept out by pest control products is commonplace. The small city of Redding in California is growing rapidly, and the increased urbanization cuts down on the native habitat of land arthropods. This investigation targets the difference in diversity between urban yards, and the undeveloped land around the Redding area. The expected results of this project were that the native, undeveloped areas would be more diverse in arthropod populations than the urban areas. Arthropod traps were

set in several developed areas and in several undeveloped areas. These traps sampled the kinds of arthropods; they were identified, and then placed into orders to be evaluated based on diversity. The findings indicated that there was not a significant difference in the diversity, but that the evenness of the arthropod orders was different between the two areas. Hymenoptera was the top order in all areas, but upon ignoring that order, the other orders were quite different. The kinds of arthropods that were supported in these areas differed.

Severity of Deterrence on Mimicked Population

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BIOL 152: Christopher Ivey

This project was motivated by the different facets of mimicry in nature. In class we created an experiment focusing on the ratios of mimics to model species and their effect on the overall success of the mimicry. Taking the experiment one step further, this project focused on the ratio of palatability in the modeled species, with the hypothesis that the more distasteful the model, the higher the survival rate of its mimic. Arrays of fake worms laced with varying levels of quinine sulfate, a distasteful chemical, were presented daily to birds to select the prey most worthy of consumption. With a high chi-squared value, the null hypothesis that the quinine sulfate would have no effect was safely rejected. The results showed that the birds overwhelmingly chose the unaltered control group of completely palatable models over the other populations with any level of quinine sulfate. However, though the quinine sulfate amount in the altered samples varied drastically, the data showed little difference in preference for either of model/mimic groups due to a high standard deviation. These results suggest that quantity rather than quality is the secret of mimicry, mimicking a common model more advantageous than an extremely unpalatable one.

Elevation Gradient of Manzanita Stomata

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BIOL 152: Don Miller

Our motivation for this project was to explore the possibility that Stomatal density could be affected by elevation. More specifically we looked at the Manzanita species *Arctostaphylos viscida*. Our hypothesis was that stomatal density would increase as the elevation increases. We came to this conclusion because as you go up in elevation the pressure drops. We imagined that the stomata of the leaves would increase their density to help release pressure to balance the plants equilibrium. To discover more about this we took a drive up Highway 162 towards Bucks Lake and made five stops on the way. At each spot we took two leafs from two different plants. We then followed the procedures in the Stomatal Density Lab to count the stomata visible in one view of the microscope using the 40x lens. Our results didn't lead to support our hypothesis. In fact our results reflected the inverse of our hypothesis. The apparent trend is that the stomatal density is actually decreasing as elevation increases. When we performed an Analysis of Variance we found the F_{crit} value to be 3.06, and our F value was 4.61. Since the F value is greater than the F_{crit} value the variation is due to elevation and not due to chance. It was interesting to find that our results showed the opposite trend that we predicted.

The Effect of Cattle Diet on *E. coli* Content in Feces

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BIOL 152: Tag Engstrom

Many domesticated cattle contain the bacterium *E. coli* in their digestive tracts. Some of this bacteria could be *E. coli*:O157:H7, a strain known to be a human pathogen. When cattle are taken into slaughter or milked, the products could be contaminated with feces containing the *E. coli*. This contamination could result in the pathogen reaching the market and making people sick. Current scientific literature indicates that certain diets of such animals may facilitate greater bacterial growth. This experiment was designed to determine whether different cattle feeding practices lead to different amounts of *E. coli* in the feces. We hypothesized that the feces of cattle on a natural diet of grass would have less *E. coli* than that of those fed corn silage. We collected fecal samples from the Chico State University Farm and plated dilutions of them on EMB agar to observe colony growth. Our results showed that cattle fed corn silage have approximately 2.3 million *E. coli* bacteria per gram of fecal matter. The data from our grass-fed cattle showed less than 0.1 million *E. coli* per gram of fecal matter. This means that cattle fed a more natural diet of grass are less likely to contain *E. coli*, and therefore any contamination that occurs through processing is unlikely to have the pathogenic strain.

The Phylogeny of Primates

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BIOL 152: Michael Marchetti

Obtaining information on the evolutionary relationships among organisms demonstrates how certain traits have evolved through time. It is known that primates are mammals, and share many characteristics with this group, but the relationship primates hold with other organisms is unfamiliar. This experiment will determine many of these associations through phylogeny. Phylogeny information was obtained through the use of Mega 4 software and the genetic sequencing data available. Organisms from terrestrial and aquatic environments were assessed as well as group of terrestrial and aquatic animals combined to give a broader view of similarities. It was determined that of the terrestrial animals chosen the flying fox showed the most resemblance, and of the aquatic animals chosen the gray whale was the most similar. The third phylogeny tree shows that of the organisms chosen the flying fox overall shares the most characteristics with primates. This provides an interesting view into the phylogenetics of primates and their relationship with terrestrial and aquatic.

Analysis of Bryophyte Diversity as a Function of Substrate

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BIOL 152: Don Miller

The purpose of this study was to analyze communities of bryophytes on two separate substrates to determine diversity of bryophyte communities as a function of substrate. Study locations were based in Upper Bidwell Park. Sites on both the Tuscan and Lovejoy Formations were chosen, and vertical transects were established with 3 sample sites per transect. Slope, aspect, and sample size were kept constant between substrates. Null hypotheses predicted no differences in diversity, and that a given bryophyte does not have a preferred substrate. The alternate hypothesis predicted greater diversity on the Lovejoy basalt, due to decreased water retention, and thus more favorable conditions for bryophyte communities. Alternate hypothesis #2 predicted that a given species would prefer Lovejoy basalt to the Tuscan formation for the same reasons mentioned above. Using soil analysis of the substrates we will try to determine if a given bryophyte species within Upper Park has a preferred substrate, and if substrate determines relative diversity and/or similarity in communities.

Detrimental Analysis of Sheep vs. Goat's fleeing distance

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BIOL 152: Tag Engstrom

Over the years many farmers and spectators have wondered what caused animals such as sheep and goats to flee at a certain distance. The main source of the animals fleeing distance can be explained by the biological principle of animal behavior. This act of fleeing is known as the animals flight zone, "animals personal space" (Sheep 201, 2010). This experiment examined the various flight distances of the domesticated sheep and goats exposed to everyday human interaction. (Hampshire X Suffolk sheep & Boar goats) In Papouchis experiment on big horn sheep, the examination was based on human development and its influence on the sheep's fleeing distance. The results stated that those animals closer to the road had a less fleeing distance compared to those exposed to hikers in the mountains. The experiment conducted at the Cal State University Chico Farm was conducted by using ten sheep and ten goats in two different 6 X 72ft pens. The animals were placed in the pens and recorded results were taken in the morning and in the evening for a one week trial period. A t-test was conducted to test the two means and produced a P-Value of $P < 0.001$. The results proved that the hypothesis, sheep take flight at a closer distance was true. Over all this study proved that the sheep took flight at a closer range than the domesticated goat.

Determining the Correlation Between Plant and Animal Species Across an Ecological Gradient

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BIOL 152: Christopher Ivey

Interaction between plant and animal species in an ecosystem is vital to the function and balance of that ecosystem. Generally speaking animals rely on plants, (producers), for energy, and plants benefit from the activities of animals that aid in spreading seeds and pollen. Ecosystems around the world are attributed to varying relationships between plant and animal diversity, the Amazon rainforest being an obvious example of a highly diverse ecosystem. The purpose of this study was to find a relationship between the diversity of plants and animals in three different sections (Creek, Ecotone, and Ridge) of Upper Bidwell Park. We hypothesize that diversity of small land-dwelling animals is directly correlated to plant diversity in the three ecosystems. To test this pitfall traps were placed in areas of the three ecosystems and left for one week. The traps were collected along with the associated plant data. Using the Shannon Index of Diversity it was determined that animal diversity was highest at the Creek ecosystem at 2.4, followed by the Ridge ecosystem at 1.5, and the Ecotone at 1.6. Plant diversity ranged from 17 at the Creek, 17 at the Ecotone, and 6 at the Ridge. This data shows that animal and plant diversity is not directly correlated, but that a general trend is apparent.

Does Higher Exposed Amounts Of Car Pollution Affect Trichome Density?

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BIOL 152: Christopher Ivey

This experiment was designed to study trichome density of a local plant Nerium Oleander in regards to measured high-traffic and low-traffic areas in Chico California. The calculated higher traffic areas were expected to also have higher amounts of pollution emitted into the direct atmosphere where the Nerium Oleander reside. Pollution is a problem in many areas of the world, which motivated our

curiosity in the affects of pollution on trichome density. From research we found trichomes work as part of a plants defense system, which brought our question, "Does car pollution affect Trichome density?" This was tested by collecting thirty separate leaves along the California 99 center freeway median in Chico, along with three separate counts of cars passed per-hour near these plants. In turn, thirty other leaves from two separate low-traffic neighborhoods were collected as well. The average cars-per hour to pass by in the high-traffic areas was one thousand and ninety two cars per hour. The trichome density to match this was calculated at one hundred forty three trichomes. The average cars per hour in the lower-traffic hour measured fifty cars per hour, with an average trichome density of sixty one trichomes. This data showed that there was an obvious affect of trichome density with how many cars had passed per hour. Although, after further research we were able to conclude that the pollution from the higher-trafficed areas did not directly affect the trichome density, but there was a correlation. We were able to conclude the higher-traffic areas also had higher wind affects on the plants in the center of the freeway. We concluded the density of trichomes was higher in defense of the higher wind flow from the cars passing by to the plants for self defense, not for affects of pollution.

Mimicry Lab Revisited

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BIOL 152: Christopher Ivey

Mimicry is a survival system that depends solely on the predator's ability to distinguish between distasteful and palatable organisms. As tested in our BIOL 152 class, the results from our mimicry experiment were inconclusive, most likely due to the style of the experiment. Lard worms were replaced with edible sunflower seeds dyed green and blue, to help distinguish between edible and non edible. Feeding trays were also used as to help prevent the birds from spilling the seeds, rather than eat them. Our control group, which were green colored sunflower seeds, contained 100% palatable individuals whereas our blue group contained $\frac{1}{2}$ distasteful (quinine sulfate added). Our hypothesis for this experiment was to determine if birds were discriminate enough with their sense of taste as to prefer the wholly palatable individuals over the non palatable ones. With results supporting our hypothesis, we will be able to provide better methods as to test mimicry in a lab. As our project is still in the field, more specifically, atop Holt Hall, hopefully it will yield results to support the basis of mimicry systems, and will allow for the adaptation of the Mimicry Lab as to be more conclusive.

Allelopathic Effects of the Invasive Tree *Ailanthus altissima* on the Germination of Radish Seeds (*Raphanus sativus*)

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BIOL 152: Tag Engstrom

Tree of Heaven (*Ailanthus altissima*) is an invasive species and is known to possess allelopathic abilities. In this experiment we tested to see if the chemicals are present in the leaves of the plants are high enough to significantly impact seed germination of radish seeds. Our results indicated that the leaves of the Tree of Heaven did significantly impact the seed germination of radish plants. Various concentrations of the leaves were applied to the radish seeds to see if seed germination was effected.

Analysis of the Relationship between Water Source the Proximity and Macro-invertebrate Populations

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BIOL 152: Christopher Ivey

In habitats with available water it has been suggested that these would also support the greatest diversity of macro invertebrates. To test this assumption 6 trapping sites were selected that bordered natural water sources, and six neighboring sites were selected that were at a distance from the water. At each site macro invertebrate diversity was measured using pitfall traps. The captured invertebrates were identified and counted. Through experimentation and ANVOA calculation, it was found that the diversity among the near water and distant from water habitats was not statically different (p-value of 0.321326), and more research would be necessary to make conclusions about the immediate effect of the proximity of available water on the diversity of macro invertebrate populations.

Ecological Gradient of Insect Density

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BIOL 152: Christopher Ivey

To determine the insect density within ecological gradients of high disturbance and low disturbance of human access. One area contains a normal house needs such as lawn, construction of a home, pets, pesticides, daily activities etc. The second area is located two hundred yards behind the property line of low disturbance of a wild life habitat. Each of the two areas contained five pit fall cups to collect the data in areas of duff, no duff, and open. Shannon Index was used to determine density. The data was also processed through Microsoft ANOVA to calculate a p-values. The results have not yet been determined.

To Eat or Not To Eat

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BIOL 152: Christopher Ivey

Batesian mimicry is a trait that helps contribute to species survival and ultimately natural selection. Evolution may occur due to the specie's trait success such as when palatable specie (mimic) takes upon the phenotypic characteristic of an unpalatable specie (model). Mimic's are able to have a better fitness and the trait is then passed onto their offspring's. However, the success of Batesian mimicry varies depending upon the population of the models and the mimics. In our experiment, we expose varying populations of models and mimics to predators in order to find out the success of Batesian mimicry. The experiment was setup in a chicken coop, in which the same chickens were exposed to unpalatable and palatable pellets. This was done by making the entire yellow pellets palatable, $\frac{3}{4}$ red pellets palatable and $\frac{1}{4}$ blue pellets palatable. As a result, we saw over time that the yellow pellets would be the ideal for the chickens, while the blue pellets were able to use Batesian mimicry better than the red pellets. Overall, there was statistically significant data from our experiment that indicated that prey with Batesian mimicry was successful in eluding predators from being eaten.

Stomatal Density in Lit and Shaded Conditions

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BIOL 152: Joel Mintzes

The stomatal density of a plant is a good indication of how well a plant absorbs CO₂ and H₂O, to photosynthesize and produce energy as well as O₂. Light is a significant factor in this process. This experiment was conducted to investigate the differences in stomatal density in leaves of *Acer negundo* that live primarily in the shaded regions in opposition to those leaves that are on the outer regions receiving the most sunlight. The leaves were collected from the inner region (shaded area) and outer region (lit area) of *Acer negundo* in south area of Holt hall near the creek. We then examined the number of stomata and counted both the bottom and top surfaces of the leaf in two separate trials. The findings reveal that the leaves in the shaded region had a greater frequency ($t=1.8$, $p < .05$) of stomata. This finding may demonstrate that the stomatal density of the shaded leaves have higher frequency to compensate for the lack of sunlight compared to those that do not lack sunlight for photosynthesis in *Acer negundo*. Further analysis reveals significant differences in frequency of stomata on the lower surfaces and upper surfaces of the lit conditions and no significant differences of the two surfaces in the shaded conditions.

Analysis of Stomatal Density With Relation to Proximity to Urban Environments

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The primary focus of this study is to determine if the proximity of a plant to urban areas and sources of CO₂ emission has any effect on stomatal density. It is postulated that plants that develop closer to urban environments will have a higher stomatal density than those that develop in a more natural setting. We will compare several samples of the same species from different locations (an urban habitat, a habitat far from significant human interference, and an intermediate habitat) and determine if there is any biologically significant difference in stomatal density among the plants.

Comparison of Stomata Densities of White-leaf VS Common Manzanita Tree Leaves

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BIOL 152: Michael Marchetti

The goal of this research project is to compare the stomatal density between the tops of the White-leaf Manzanita and Common Manzanita leaves. Twenty leaves were collected off of highway 32 from each of the Manzanita trees. After collection, the stomata were counted using dissecting microscopes. We observed that the White-leaf Manzanita had a higher average of stomata count than did the Common Manzanita leaf. Upon obtaining a p-value of less than .05, we can conclude that there is a significant difference between the stomatal densities of White-leaf and Common Manzanita leaves.

The Comparison of Stomatal density in *Liquidambar styraciflua* between Chico and Redding *Acer palmatum* Sango Kaku: Stomatal Density Between Red and Green leaves

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BIOL 152: Don Miller

Sango kaku (*Acer palmatum*), which is a deciduous shrub reaching heights of 6-10 m, displays considerable genetic variation such as: leaf size, shape, and color. Sango kaku is a kind of plant that

produces two different colored leaves on separate trees; green and red. We performed an experiment on these two different colored leaves to see whether they differ in stomatal density. We also compared leaves to see if there is any difference in stomatal density between the upper and lower surfaces of the red and green leaves individually. The t-tests revealed differences between the upper and lower surfaces of the red leaves ($t=6.73$, $p<.01$) and the green leaves ($t=8.46$, $p<.01$) with significantly more stomata found on the lower surfaces of each. However, no overall differences were found in stomatal density by leaf color ($t=0.78$, $p>.05$).

Acer Palmatum Sango Kaku: Stomatal Density Between Red and Green leaves

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BIOL 152

Sango kaku (*Acer Palmatum*), which is a deciduous shrub reaching heights of 6-10 m, displays considerable genetic variation such as: leaf size, shape, and color. Sanga kaku is a kind of plant that produces two different colored leaves on separate trees; green and red. We performed an experiment on these two different colored leaves to see whether they differ in stomatal density. We also compared leaves to see if there is any difference in stomatal density between the upper and lower surfaces of the red and green leaves individually. The t-tests revealed differences between the upper and lower surfaces of the red leaves ($t=6.73$, $p<.01$) and the green leaves ($t=8.46$, $p<.01$) with significantly more stomata found on the lower surfaces of each. However, no overall differences were found in stomatal density by leaf color ($t=0.78$, $p>.05$).

Birds Selection of Habitat –Riparian vs. Urban

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BIOL 152: Don Miller

We examined the diversity and species richness of two settings: Riparian (Big Chico Creek) and Urban (Chico State Campus around Legion Ave and Mansion Ave). A total number of 15 species were counted, totaling 106 individuals. We found the sparrows and the Starling to be the common species throughout the study (sparrows =43, Starling=25). Based off this information we calculated Shannon indices, and found that Big Chico Creek had a higher diversity ($=1.4256$) than the urban setting ($=.71297$). We can say with 95% accuracy that the riparian area is more diverse than the urban area ($t=2.67$, $df=6$, $p\text{-value}=0.05$).

Fishing Project

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BIOL 152: Tag Engstrom

The aim of this study was to investigate the effects of an auditory component on the successful landing of smallmouth bass. Components affecting the success rate of hooking include fish, location, and presentation. All fishing was conducted in the McCloud Arm of Shasta Lake from one boat using the same rig (set-up of lure) for both groups with our experimental group also containing an auditory component. Over the course of the six days, eighteen (18) were caught under the control group conditions and fourteen (14) under the experimental group conditions. Based upon the T-test results, no significant difference could be determined from the data recorded. Analysis of these results show that there is no benefit to the use of an auditory component under the conditions specified.

Upper Division Class Projects

Heat-killed pollen produces shorter closure periods on thigmonastic stigmas of *Mimulus guttatus* and *M. glaucescens*

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BIOL 369: Chris Ivey

Thigmonasty is plant movement in response to touch, which is thought to be regulated by chemical signaling throughout the plant. It can be seen by closure of the bi-lobed stigmata in many flowers of the Scrophulariales order. The flowers *Mimulus guttatus* and *Mimulus glaucescens* are in this order and possess thigmonastic stigmata. We looked at stigma closing and reopening in these *Mimulus* species, with the application of different pollen types: live, heat-killed, conspecific, and heterospecific. We assessed the time it took the stigmata to reopen and compared the categories of live vs. heat-killed pollen, conspecific vs. heterospecific pollen, and pollen applied to *M. glaucescens* vs. *M. guttatus* stigmata. We found that live pollen causes stigmata to remain closed longer than heat-killed pollen. It appears that upon pollen death changes in pollen physical structure or pollen mechanisms is sensed by stigmata and leads to reopening.

A study in reproductive isolation in two *Mimulus* species.

Janice Morris and Herman Gray

BIOL 369: Chris Ivey

This was a study in reproductive isolation between *Mimulus guttatus* and *Mimulus glaucescens*. Experiments were conducted by class members to see if there was pollen competition at various stages of pre-zygotic stages including germination, pollen tube growth and pollen ovule interaction. My partner and I were responsible for post zygotic seed set. We manually pollinated conspecific and heterospecific crosses, waited for seed set and then counted the seed. Our results showed that hybridization did occur, showing no significant reproductive isolation at this stage.

Proportion of pollen germination as a reproductive isolation barrier between *Mimulus guttatus* and *M. glaucescens*

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BIOL 369: Chris Ivey

Speciation requires a series of reproductive isolation barriers between the two “types” of organisms. Hybridization often occurs between closely related species. To determine the extent of speciation between sister species, reproductive isolation factors, such as germination proportion of pollen grains on conspecific versus heterospecific crosses, were examined in *Mimulus guttatus* and *M. glaucescens*. A sound method for analysis of heterospecific versus conspecific germination was established using hand pollinations and fluorescent staining and mercury fluorescence microscopy in order to determine a proportion of total pollen grains to pollen grains germinated.

Asymmetry in pollen tube growth rate in heterospecific crosses between *Mimulus guttatus* and *M. glaucescens*.

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BIOL 369: Chris Ivey

Among closely related plant species that share similar geographic regions, it is often unavoidable that some cross-pollination will occur; if a certain plant population is to prevent gene flow entirely, additional isolating barriers must be imposed. Using *M. guttatus* and *M. glaucescens*, we pollinated conspecific and heterospecific crosses and measured the length of time it took for pollen tubes to emerge from the end of the dissected style. Our results indicated that, though there appeared to be no reproductive isolating barrier within the style environment, *M. glaucescens* pollen grew significantly faster regardless of the style species. This asymmetric introgression has been noted between other species and could provide clues to past evolutionary divergence and insight into the still-mysterious processes of speciation.

The Enrichment for Cellulose Degrading Bacteria

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It is accepted that microorganisms rarely exist in the natural environment as pure cultures, which advances research in developing new techniques and methods of selecting for particular microorganisms. The isolation and purification of cellulose degrading bacteria was the main goal from the mixed culture collected outside Holt Hall. Cellulose is a naturally abundant polymer made by plants and commonly undergoes degradation due to specific bacteria and fungi. We suspended two samples of decaying wood and leaf material in deionized water and vortexed to suspend the cells. We inoculated 4 CMC (carboxy methyl cellulose) agar plates and incubated for one week in 28°C until colony formation. Less than 100 colonies grew at about one week post-inoculation and were small, circular, white, fuzzy colonies with repeating rings around the colony perimeter. To determine if the cells were growing on some other nutritional source within the CMC plates we re-streaked on TSA (tryptocase soy agar) plates which were contaminated. We re-streaked for isolation 3 times on CMC for a pure culture. Further phenotypic tests determined our organism to be a G+ rod/ chain, - growth for oxygen utilization, - motility, H₂O₂ + catalase and – spores. We are waiting on genotypic results (16s rRNA).

Isolation of Petroleum Degradar From a Soil Sample of a Street Runoff Near Holt Hall Which Can Utilize Motor Oil

Jaquelyn Magaña, Shirely Nichols, Zohra Obaidi, Gabriel Ruiz
BIOL 371: Gordon Wolfe

Some bacteria are able to utilize diverse carbon sources such as petroleum and other oil sources. Petroleum degrading bacteria are commonly found in areas with frequent oil residue such as highway runoffs and areas with frequent oil spills. The sample for analysis was collected from a roadside gutter East of Holt Hall on Arcadia street. The sample was inoculated on lubricant oil agar plates which were prepared using Miracle Gro® as a source of additional nutrition. From these plates colonies were chosen for re-streaking in order to isolate an oil degrader, however, gram stain displayed mixed results of positive and negative bacillus. Colonies were then re-streaked on to TSA plates and incubated at 37C, which produced two pure colonies. One of the colonies was a raised round golden glossy gram negative and the other colony was a round flat dull white gram positive

colony. Motility, Urea, Indole, Catalase, and Oxidase tests were performed on the isolates. Both isolates tested positive for the Catalase enzyme, negative for Indole, and the gram negative had a positive test result for Oxidase while the gram positive had a negative test result. Each of these isolates were then inoculated into one plate each of a clean motor oil agar prepared plate as well as a mixed used motor oil agar prepared plate and incubated at 37C to observe whether the isolated oil degraders preferred clean motor oil or motor oil from mixed used sources.

Enrichment of Nitrogen-Fixing *Azotobacter*

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BIOL 371: Gordon Wolfe

Nitrogen fixing bacteria are ecologically important microbes that reduce atmospheric nitrogen to ammonia, which is then converted to biologically available forms. *Azotobacter* is a free-living Gram negative nitrogen fixer, which produces a slime layer in the presence of carbohydrates. The slime layer protects the O₂ sensitive enzyme, nitrogenase, which allows the bacterium to fix nitrogen. To enrich for these nitrogen fixers, we inoculated nitrogen-free agar plates with nitrogen poor soil. The nitrogen-free agar we prepared contained sucrose as an organic carbon source, various salts, and a small amount of molybdenum, which the nitrogenase needs for the reduction of nitrogen. The plates were incubated in the dark at room temperature in order to inhibit the growth of photosynthetic bacteria, such as *Cyanobacterium*. The bacterial colonies were re-streaked for isolation three times over a four week period. The bacteria are small rods which tested Gram negative. A motility test was inconclusive because the bacterium is strictly aerobic and did not grow within the media. Colonies are clear and colorless and have a shiny slimy layer. There were filaments embedded within the nitrogen free agar which could be a contaminating organism or filaments produced by our nitrogen-fixing organism. Genetic sequencing is being performed for further identification; results are pending.

Enrichment of Myxobacteria from Rabbit Dung

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BIOL 371: Gordon Wolfe

Myxobacteria are Gram-negative predatory bacteria that can be found in decaying organic material. These organisms have complex, social life cycles that include formation of multicellular fruiting bodies with internal myxospores when resources become scarce and the coordination of groups of cells to form gliding, multicellular swarms (Shimkets, 1990). Myxobacteria prey on many different types of bacteria, including both gram-positive and gram-negative species. Myxobacteria can be difficult to isolate because they can be so easily outgrown by their prey. Several methods were attempted, making use of the ability of these organisms to grow on media lacking any nutrients. Using water agar and *Bacillus megaterium*, a gram-positive prey of myxobacteria, a species of *Myxococcus* was enriched from rabbit dung pellets. Many isolation attempts were performed, but with limited success. Further attempts could include the use of various medias to encourage the growth of myxobacteria over the growth of their prey.

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Isolation and characterization of Phototrophic Autotrophs in Chico Creek

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BIOL 371: Gordon Wolfe

Algae, a unique phototrophic organism renowned for their proliferation in diverse environmental conditions have inhabited the Earth for over three billion years. These photosynthetic organisms range from unicellular to multicellular stalks with complex life cycles.² Believed to be an organism originating from the Precambrian period, algae are thought to be descendants from cyanobacteria.² These bacteria known as cyanobacteria are composed almost entirely of chlorophyll giving a blue-green color.¹ These free living prokaryotes have been transformed into the plastid organelles we see today in algae. These plastids catalyze the formation of essential sugars the alga needs using carbon dioxide as a carbon source, and producing oxygen as a side-product. Our project focused on isolation and characterization of Phototrophic Autotrophs in Chico Creek. Isolation was conducted using a liquid media composed of salt, miracle-gro, magnesium sulfate, sodium bicarbonate, calcium chloride and some salt metals. Throughout the enrichment we wanted to make sure no organic carbon was present for other organisms to take off with. Four milk bottles (500ml) were filled up with 150 ml of liquid media and 50 ml of stream/sediment supernatant from Chico Creek. Samples were incubated at room temperature next to a window sill for two weeks. As a result, a mixed culture was obtained of both unicellular photosynthetic organisms with organelles and without organelles. Samples were diluted 10^{-3} and cycloheximide was added to observe differences in fluorescence. Using a fluorescent microscope a fluorescence knockdown on the order of 90% was observed between samples treated with cycloheximide and without. Altogether, all isolates grew up dark green algae as indicated when using solid media. With cycloheximide being a eukaryotic translational inhibitor and the unicellular photosynthetic organisms having organelles, we have successfully isolated a type of green Algae.

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Utilization of Tri-Template Polymerase Chain Reaction for Gene Fusion in *Arabidopsis thaliana*

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BIOL 409: Kristopher Blee

Conventionally, bioengineering techniques have implemented restriction enzymes and ligation protocols to manipulate genes for investigation. Recent data indicates that tri-template polymerase chain reaction (tt-PCR) will provide a more efficient method by which these constructs can be synthesized. This project aimed to utilize tt-PCR to create a novel construct from its constituent fragments through a single step tri-template reaction. Class III secretory peroxidase genes from *Arabidopsis thaliana* provide a model system for investigation of the tt-PCR procedure. The objective of this experiment was modification through replacement of the C-terminus of a peroxidase gene. Using tt-PCR, yellow fluorescence protein (YFP) gene was inserted prior to the C-terminus to label and identify the sub-cellular destination of the modified peroxidase protein. Four primers were designed with complementary extensions to amplify two segments of three different *A. thaliana* genes. Each individual fragment was independently amplified via PCR and quantified before use in

the tri-template reaction to synthesize the complete peroxidase/YFP gene construct. Based on data gathered from gel electrophoresis, it can be concluded that the tt-PCR reaction provides a novel and efficient mechanism to bioengineer investigatory constructs.

Importance of the C-terminus in the Expression of Class III Peroxidase Genes in *Arabidopsis thaliana*

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BIOL 409: Kristopher Blee

Class III peroxidase genes of *Arabidopsis thaliana* are involved in the formation of lignin. The N-terminus of a peroxidase gene signals where the gene will be expressed. The C-terminus determines if the peroxidase will direct secreted proteins of the plant to the outside of the cell or to the vacuole. By tracking the recombinant gene created from peroxidase genes AT4G21960.1 and AT1G71695.1 it can be determined where in the cell the peroxidase is expressed. Genomic DNA was isolated from *A. thaliana* leaves and first round tri-template PCR was used to retrieve gene specific components required to engineer yellow fluorescent protein (YFP) reporters. PCR generated fragments of AT4G21960.1 and AT1G71695.1 were used to create the recombinant gene tagged with YFP. The recombinant was transformed into *Agrobacterium tumefaciens* which was used to inoculate *A. thaliana* flowers. Seeds were collected, surface sterilized and germinated on kanamycin media. Seedlings were screened using fluorescence and confocal microscopy. The presence of 3µg/µL of the recombinant gene was confirmed using gel electrophoresis. Transformation into *A. thaliana* was successful, showing an efficiency rate of 4.68% on day 10 after plating on kanamycin media. Using confocal microscopy fluorescence was seen in the vacuoles in one of the three seedlings observed on day 10. Fluorescence was only seen in the cell walls of the control plant. The appearance of fluorescence in the vacuole is consistent with the expected contribution of the hydrophobic C-terminus of AT1G71695 which directs peroxidase expression to the vacuole.

Identification of Genes Involved in Prodigiosin Pigment Biosynthesis in *Serratia Marcescens* via Transposon Mutagenesis

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Prodigiosin is a red pigment with antibiotic properties produced by the gram negative bacterium *Serratia marcescens*. The prodigiosin biosynthetic pathway is organized as a fourteen gene operon ordered *pigA* through *pigN*, and has been well characterized. However, genes with accessory or regulatory mechanism are largely unknown. The goal of this project was to identify genes involved in the regulation and production of prodigiosin biosynthesis. Seventeen *Serratia marcescens* prodigiosin mutants were generated via transposon mutagenesis. Mutant phenotypes ranged from completely pigmentless to hyper-pigmented. The chromosomal transposon insertion sites were successfully cloned in fourteen of the mutants and sequence data was obtained from eleven clones. The genes disrupted by the transposon insertions were varied. Four of the mutations were within the *Serratia pig* cluster as expected. Several potential genes with either regulatory or accessory function were also identified. These include a sensor histidine kinase, a phosphate transporter, a polynucleotidyltransferase, and a two component transcriptional regulator, as well as others. These results suggest we have identified novel genes that effect the production of prodigiosin in *Serratia marcescens*.

Potassium Chloride Induced Excitotoxicity: Cyclosporine A is Neuroprotective in Transgenic Mice

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BIOL 418: Jonathan Day

Glutamate (Glu) is an integral neurotransmitter in neuron synapses, causing depolarization and calcium (Ca^{2+}) influx. High concentrations of Glu can induce excitotoxicity, leading to high Ca^{2+} within the neuron leading to mitochondrial dysfunction and cell death. Previous research has shown Cyclosporine A (CsA) to have a direct neuroprotective effect from Glu insult *in vivo* and *in vitro*. Similar to Glu, high potassium chloride (KCl) can induce excitotoxicity; to confirm that CsA works through a Ca^{2+} mediated pathway, a KCl induced over-excitation procedure was used. It was hypothesized that CsA acts as a neuroprotectant by blocking Ca^{2+} channels in the mitochondrial membrane resulting in higher viability of cells after KCl insult. In addition to demonstrating KCl excitotoxicity in rats, B6 and FVB transgenic mice were used to determine the role of GluR2 in excitotoxic events. Cells were pretreated with 25 μM CsA followed by 60 μM KCl, rinsed and incubated for 24 hours prior to viability assay, analyzed by one way ANOVA and Dunnett's post hoc analysis. Rat cells treated with CsA prior to KCl insult showed 81% viability compared to non-pretreated cells showing 29% viability ($P < 0.0259$). In B6 mice, 85% of cells and 75% of cells in FVB treated with CsA survived KCl insult, compared to 35% survival of 60 μM KCl alone for both strains (B6: $P < 0.1191$, FVB: $P < 0.0001$). These results indicate excitotoxicity relying on a Ca^{2+} mediated pathway.

Cyclosporine A promotes synaptogenesis in rat hippocampal neurons *in vitro*

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BIOL 418: Jonathan Day

Neurodegeneration can result from disease, trauma, ischemia and other homeostatic disruptions. Increased synaptic formation in surviving neurons can help to slow the progression of neurodegeneration. Cyclosporin A (CsA) is a cancer treatment drug that has been found to promote synapse formation through the inhibition of calcineurin. In this experiment we constructed a dose-response curve for CsA concentration and synapse number *in vitro*. Cultured neonatal rat hippocampal neurons were treated for 15 minutes with varying concentrations of CsA and then incubated one hour. Active synapses were identified using FM4-64 fluorescent dye. This dye illuminates sites of exocytosis associated with neurotransmitter release which is indicative of synaptic activity. Our results showed that as the concentration of CsA increased, the number of active synapses also increased. This relationship was represented by an upward linear trend. Compared to our control sample, our data showed significant increases in synaptic formation at concentrations of CsA as low as 12 μM . CsA is already approved for use in humans, and our results provide further evidence that it could be used as treatment for individuals experiencing neurodegeneration.

Characterization of Bacteriophages Isolated from Raw Sewage

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BIOL 476: Larry Hanne

Viruses that infect bacteria are designated as bacteriophage, or phage for short. Phage are usually host-specific. The objective of these studies was to enrich for phage that individually infect the bacterium *Klebsiella pneumoniae* or different strains of *E. coli* and study their characteristics through a series of experiments. Five different phage were isolated from sewage and plaque purified. Results for detection of an envelope showed that all of the phage were non-enveloped. Three of the five phage infected multiple hosts and the other two were specific for only one host. All five phage followed single hit kinetics. The percent attachment of phage to a non-natural host ranged from 5% to 95% and 63% to 95% for attachment to the natural host. Phage burst size for two of the phage was determined by one-step growth curve, and ranged from 280 to 950. The phage genome size was determined for only one phage and found to be approx 40 kilobases. There were two to three major virion proteins detected from each phage. The protein sizes ranged from 14 to 36 kilodaltons.

Development of a protocol for monitoring of foothill yellow-legged frogs, *Rana boylei*, in Big Chico Creek Ecological Reserve

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The foothill yellow-legged frog (FYLF) is federally listed as a species of concern and a California species of special concern. FYLF are found from Los Angeles County to the south and northwards as far as Oregon in the coast range and on the western slopes of the Sierra Nevada and Cascade ranges under 6,000 feet above sea level, although most are found below 2,500 feet. There is a substantial population of FYLF found in the Big Chico Creek Ecological Reserve (BCCER), however there has been no systematic effort to quantify or monitor populations within the reserve. Here we present a detailed protocol, developed by our Field Ecology (BIOL 484) class in conjunction with staff and interns at the BCCER, for ongoing monitoring of FYLF in the reserve and present baseline data for abundance and distribution within two tributaries of Big Chico Creek. In our surveys, conducted between February and April 2010, we found that FYLF were abundant. Our counts were variable, however, due to precipitation; higher numbers of FYLF found in the tributaries seem to coincide with dryer weather, while lower numbers seem to coincide with wet weather. These observations lead us to believe that the frogs are using upland habitat during rain events in the non-breeding season. The significance of our findings includes guidance of management efforts for reliable monitoring of FYLF, especially with regard to temperature and precipitation. Additionally, utilization of small tributaries and upland habitats is a novel natural history observation for the species.

Undergraduate Research

Behavioral Study of Elephants in Zimbabwe Wildlife Sanctuary

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BIOL 489: Patricia Edelmann

Behaviors of 16 African Elephants, *Loxodonta africana*, were monitored over a period of five weeks at the wildlife sanctuary and orphanage operated by the Wild Horizons Trust in Victoria Falls, Zimbabwe. Observations were carried out to assess the individual and interactive behaviors of the elephants.

Analyzing The Effects Of ABO Mismatch On Stem Cell Transplant Engraftment

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BIOL 399: Ailsie McEnteggart

There was no significant difference in the success of engraftment between ABO matched and ABO mismatched in stem cell transplants (SCT). Patients included in the study were treated at UC Davis between 08/19/05 and 05/07/09. These patients underwent allogeneic SCT, recipient/donor pairs were either ABO matched, major mismatched, minor mismatched or bidirectional mismatched. The objective of this study was to identify donor recipient ABO mismatched SCT and compare transfusion requirements, complication and time to engraftment with allogeneic ABO matched SCT. There were no significant correlations between several variables: Age, diagnosis, Graft verse host disease (GVHD) and type of ABO mismatch. ABO mismatch does not interfere with stem cell engraftment. Undergraduate independent/group project – Biol 399/Chem 490

Vegetative characteristics of an eroded stream bank in the Big Chico Creek Ecological Reserve

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GEOS 575: Randy Senock

Analyses of two stream bank sites were made in the Big Chico Creek Ecological Reserve to compare and contrast the vegetative composition. One bank, located near an access road to the creek, has experienced significant erosion. The other, located in the same vicinity and showing similar stream characteristics, has experienced none. Riparian vegetation is a main focus within the study of ecology, and the importance of certain types of plants play an integral role in managing stream bank erosion in these areas. The studies and research presented in this commentary support the findings that the absence of woody vegetation near the stream bank is associated with bank erosion.

Glutamic Acid Induced Excitotoxicity: Cyclosporine A is Neuroprotective in FVB Mice but Limited in B6 mice

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BIOL 499H: Jonathan Day

Glutamate (Glu) is an excitatory neurotransmitter in the brain that binds to ionotropic receptors located on the postsynaptic membrane and allows calcium into the cell. Elevated levels of Glu can induce excitotoxicity, resulting in high intracellular calcium concentrations which disrupt mitochondrial function and lead to cell death. It has been shown that Cyclosporine-A (CsA) is neuroprotective against excitotoxicity in rats and FVB mice, but might cause resistant B6 mice to become susceptible at higher doses. We hypothesize that if CsA is neuroprotective in FVB, but causes B6 to become susceptible at high doses, then application of CsA prior to excitotoxic insult should

result in increasing FVB viability and decreasing B6 viability with increasing CsA concentration. To test the effects of CsA, FVB and B6 neurons were pretreated with 25uM CsA for 15 minutes then treated with three concentrations of 100uM Glu for 15 more minutes. Neurons were incubated overnight, rinsed, stained with a viability assay, and analyzed by one-way ANOVA and Dunnett's post-hoc analysis. Results showed that CsA was neuroprotective in both mice. On average, 70% of FVB cells pretreated with CsA survived insult, compared to 32% survival for insult alone ($P < 0.003$). 46-66% of B6 cells pretreated with CsA survived insult, compared to 53% survival for insult alone ($P < 0.3720$). Although B6 cells treated with CsA weren't significantly different from Glu insult alone, there was a slight decrease in viability with increasing CsA concentration. These data support our hypothesis and demonstrate that CsA can be neuroprotective but limited depending genetic factors.

Conversion of rice hulls and food waste to a biodegradable plastic, polylactate (PLA)

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BIOL 399: Larry F. Hanne, Larry L. Kirk¹, Joseph Greene²

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Conversion of rice and food waste into polylactate (PLA) involves a four step process: (1) Pretreatment to release glucose; (2) Fermentation of glucose to lactic acid; (3) Purification of lactic acid; (4) Polymerization of lactic acid to PLA. Our research involves using agricultural and food waste (rice hulls and cafeteria food waste) as nutrients for the fermentation step. Rice hulls contain approx 28-38% cellulose. This cellulose can be broken down into glucose that can serve as a nutrient source for bacterial production of lactic acid. In step 1, optimum pretreatment conditions for rice hulls were 0.5% sulfuric acid or 2.5% NaOH followed by cellulase digestion. In step 2, glucose released by the pretreatment was combined with cafeteria food waste (a nitrogen source) for the bacterial fermentation to lactic acid. We now have a protocol where lactic acid can be produced completely from waste material. In step 3, lactic acid was removed from the final bacterial culture using a multi-step process: centrifugation to remove solids, decolorization using charcoal (97% yield), and finally anion exchange chromatography to isolate lactic acid from the remaining impurities (63% yield). In step 4, the PLA polymer was synthesized from lactic acid in a two-step process. We have successfully completed both steps of the synthesis. The yield for the first step has been relatively low, and we are working on changes of the distillation equipment to improve this step. The yield for the second step is 91% and generates PLA with an average molecular weight of 8381g/mole.

Correlated selection for mating system and developmental traits in *Mimulus guttatus*

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BIOL 399: Chris Ivey

Variation in plant reproductive strategies exceeds that of any other group of organisms, thus understanding how mating systems evolve has been of interest to many biologists. Within the genus *Mimulus*, there is wide variation among species in mating system, flowering time, and antiherbivore traits. Previous studies within the species *Mimulus guttatus* have identified correlations among traits associated with self-fertilization, reduced antiherbivore defense, and life history traits associated with rapid development, such as flowering time. We examined phenotypic correlations and measured phenotypic selection for 10 traits in a field population of *Mimulus guttatus* to test the hypothesis that previously reported trait combinations are adaptive under natural conditions. Three of 31 predicted correlations were statistically significant, although all were opposite of the predicted sign. In univariate models, three of the 10 traits (date of first flower opening, flower width, and

flower length) had significant directional selection coefficients. In a multiple regression, however, we found evidence for correlated selection of flower length and date of first flower opening. Results suggested that adaptive phenotypic combinations included early flowering with large flowers or late flowering with small flowers, indicating divergent selection for these trait combinations. Adaptive phenotypes therefore contrast with predicted patterns, as well as observed patterns among taxa within the genus. Based on these preliminary but provocative results, we anticipate contrasting rates of realized self-fertilization in the progeny of these extreme phenotypes. Our continuing analyses will focus on tests of this prediction.

Production of Lipid Bodies and Neutral Lipid in Haptophyte Algae: Effects of Life Cycle, Bicarbonate Dosing, and Inhibitors

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BIOL 399: Gordon Wolfe

The marine haptophyte algae *Emiliania huxleyi* and *Isochrysis galbana* produce a suite of unusual PolyUnsaturated Long-Chain Alkenones, Alkenoates, and Alkenes (PULCA) as their major neutral lipids, which may have potential as biofuels. Recent proteomics work (Wolfe & Erlendson, submitted) has implicated novel fatty acid synthase (FAS) or polyketide synthase (PKS) systems in their biosynthesis, and suggested that packaging of lipids into lipid bodies (LBs) may vary with cell life cycle phase. In this study, I used the neutral lipid stain Nile Red to examine differences in lipid body structure between haploid and diploid phase cells. Known 1N cells (*Isochrysis galbana*, *E. huxleyi* CCMP 379) have well-defined Nile Red-staining LBs, while 2N *E. huxleyi* strains show neutral lipid co-localizing with the cell wall, in agreement with prior predictions. Also as predicted, dosing lipid-depleted cells with 10 mM bicarbonate under nutrient-limited high light conditions results in vastly increased PULCA and LB production. This is largely inhibited by addition of 20 μ M cerulenin, a specific inhibitor of ketoacyl-ACP synthase in type I fatty acid synthases, confirming earlier observations that cerulenin inhibits lipid flux into PULCA pools.

Terrestrial Amphibian and Reptile Survey Design For Big Chico Creek Ecological Reserve

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BIOL 399: Colleen Hatfield

Big Chico Creek Ecological Reserve contains many different habitats that provide homes for numerous amphibian and reptile species. A systematic approach for collecting information on what species are present within the reserve was needed to create an accurate and comprehensive inventory. Using coverboards in occurrence with visual encounter surveys would allow for a simple and clear way to conduct surveys for terrestrial amphibians and reptiles and to create an inventory. Coverboard placement was determined with the following variables in mind: spatial separation, accessibility, sampling of all main habitats, following elevation gradients, and repeatability. Conducting coverboard and visual surveys for terrestrial amphibians and reptiles proved to be an effective approach to systematically collecting information of species' presence within the reserve. Furthermore long-term data collection can lead to future monitoring projects within the reserve.

Investigation of Moisture Dependency and Microhabitat Use of *Batrachoseps attenuates* in the Big Chico Creek Ecological Reserve

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BIOL 399: Tag Engstrom

Amphibians exhibit a high degree of sensitivity to habitat change and are often used as environmental indicators (Williams, 2003). Slender salamanders (*Batrachoseps attenuates*) are the most abundant amphibian found in the Big Chico Ecological Reserve (BCCER) and yet, very little research has taken place to elucidate basic ecological characteristics of the species. The overall goal of this project was to provide baseline data on the moisture dependency, microhabitat use, and relative abundance of the species for reference in any future studies. As possible vectors for the chitrid fungus to enter the BCCER and possible indicators of climate change, this baseline study and development of field protocol can be used to monitor change in long term studies. Ten transects throughout the BCCER were monitored from September 2009 until May 2010. From the results of this monitoring program it was discovered that an initial soil saturation of around 5% relative humidity is necessary for *B.attenuatus* to become active. Salamanders showed a strong preference for woody debris over rock and exhibited a pronounced decrease in abundance on steep transects.

GRADUATE CLASS PROJECTS

Predicting microRNA Targets Using Gene Expression Data

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BIOL 612: Dave Keller, Andrea White

MicroRNA molecules regulate cell processes by binding to target messenger RNA molecules and inhibiting translation. Dysregulation of microRNA is implicated in diseases such as cancer and type 2 diabetes. Understanding targets of microRNAs could help control these diseases. Each microRNA is expected to have hundreds of targets. Yet only a small number targets have been experimentally verified. Current prediction methods use algorithms to search genomic sequences for binding sites. These methods identify thousands of potential microRNA targets. However, target verification is costly, time consuming, and many predictions are false positives. To identify the most probable biologically important predicted targets, algorithm data sets can be compared to gene expression data sets. Genes predicted by both data sets are considered biologically relevant microRNA targets. These genes are good candidates for further verification. Here, a sample analysis was performed for microRNA-375 using two sets of gene expression data and two algorithms. This analysis revealed thirteen possible microRNA-375 targets of interest.

Bioinformatics Application for the Determination of Coreceptor usage by the HIV-1 gp 120 v3 loop

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BIOL 612: Dave Keller, Andrea White

The v3 loop of the HIV-1 virus genome is the most variable region of glycoprotein 120. This variability has a direct effect on the nature of its virulence. The v3 loop is comprised of 35 amino acids and it is also the key determinant factor for coreceptors (ccr5 or cxcr 4) selection. Currently, viral-host interaction is poorly understood phenomenon. Within the host cells, the virus switches coreceptors during disease progression from carrier to AIDS (ccr5 to ccr4). (Chalmet et al., 2008). Understanding this conversion and in general, viral-host coreceptor interaction is the key for future coreceptor

based antiretroviral drugs. There are several methodologies which help researchers determine whether a specific virus uses ccr5 or cxcr4. One of the simplest and widely used sequence based method is the 11/25 rule. In this rule the virus uses cxcr4 coreceptor, if the amino acid at position 11 or 25 is positively charged (Sander et al., 2007). In this bioinformatics experiment, several strains of HIV-1 virus amino acid sequences will be analyzed using Mullin's Lab, position specific scoring matrices (PSSM) to determine which coreceptors are used by the specific virus. Several genomics browsers will be used to find these strains. The goal of this bioinformatics project is to determine the variability of viral coreceptor usage and depending on the availability of data; this research could be extended to studying viral coreceptor usage from initial entry of the virus (onset) to disease progression.

Distribution and Conservation of Phosphonate Metabolism Operons in Bacteria

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BIOL 612: Dave Keller, Andrea White

The C-P lyase pathway utilized by microbes to metabolize phosphonates is not well understood but has been investigated extensively because of its importance in the biodegradation of phosphonates. Previously, *Pseudomonas stutzeri* was identified as having two distinct C-P lyase pathways. The *phn* encoded pathway has been well characterized and the *htx* encoded pathway appeared unique to *P. stutzeri*. In this study, public sequence data was used to investigate the distribution and conservation of C-P lyase operons. Phylogenetic analysis suggests that C-P lyase pathways fall into two distinct groups, one sharing most homology with *htx* and one that is most homologous with *phn*. Two additional organisms with multiple copies of C-P lyase operons were identified. Two strains of *Marinobacter aquairolei* have both a chromosomal and plasmid copy, both of which are of the *htx* class. *Methylobium petroleiphilum* has two plasmid encoded operons, which are nearly identical to one another and appear to be a hybrid of both *phn* and *htx* proteins. The presence of multiple and divergent C-P lyase operons in many organisms supports the importance of these pathways to bacteria, and provides insight into the mechanisms of gene transfer and phosphonate degradation.

Intron removal mechanism and sequence directed alternative splicing of the HB52II small nucleolar RNA

Meghann Shorrock

BIOL 612: Dave Keller, Andrea White

Most eukaryotic genomes are choked with intronic segments of non-coding sequences that must be removed from pre-mRNA before translation. Traditionally regarded as genomic junk, these intron sequences have recently been shown to actively influence gene expression by becoming regulatory RNA and/or dictating alternative splicing, a major source of diversity in higher organisms. HB52II is a class of small nucleolar RNAs (snoRNA) essential to brain development. This study determined the genetic origin of this vital regulatory RNA and predicted that its introns will be removed via a sophisticated spliceosome mechanism rather than by a self-splicing reaction. Using Ensembl genome browser, a search for the conserved splicing sequences housed within each intron showed all were removed via a spliceosome. However, identification of alternative splice sites based solely on sequence conservation was limited due to lack of bioinformatic tools dedicated to non-coding regions of genome. The prevalence and significance of non-coding sequences in genetic regulation and diversity is still being realized. This study emphasizes the need for a departure from traditional protein centered approaches to development, molecular genetics, and bioinformatic studies.

Galling leaf aphids and common manzanita shrubs: a case of commensalism?

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BIOL 672: Christopher Ivey

Plant-herbivore interactions are generally considered to be predatory or parasitic. We studied the effect of herbivory by the gall-forming aphid, *Tamalia coweni*, on the leaves of common manzanita shrub, *Arctostaphylos manzanita* ssp. *manzanita*, to test the hypothesis that the galls on a common manzanita shrub negatively affect the shrub's fitness. We sampled common manzanita shrubs at the Big Chico Creek Ecological Reserve in Butte County, and measured density of galls, number of flowers and fruits, and number of inflorescences. Reproductive effort (number of flowers/fruits and inflorescences) was used as the measure of fitness. We found no significant relationship between gall density and plant reproductive effort. Therefore, our data do not support the hypothesis that galls produced by galling aphids negatively affect common manzanita shrub fitness. Although common manzanita benefits the aphids, galls appear to have no significant effect on plant fitness. Instead of predation or parasitism, the plant-herbivore relationship that we documented appears commensalistic.

Pollen tube growth rate as a barrier to hybridization between sister species *Mimulus glaucescens* and *Mimulus guttatus*

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BIOL 672: Christopher Ivey

Speciation produces sister species that have accumulated subtle genetic differences that combine to influence overall reproductive isolation. These isolating mechanisms occur sequentially, with prezygotic barriers acting before postzygotic. In flowering plants, differences in pollen tube growth rates between species can provide a mechanism for reproductive isolation, and can affect seed siring success. In this study I investigated whether differences in pollen tube growth rate are significant enough to provide a barrier to reproduction between sister species *Mimulus glaucescens*, and *M. guttatus*. Using conspecific and heterospecific crosses, pollen tube growth rate was measured. No significant differences were observed, suggesting that pollen tube growth rate is not a major contributor to overall reproductive isolation between *M. glaucescens* and *M. guttatus*.

Postzygotic reproductive isolation: exploring seed set after crossing the sister species *Mimulus guttatus* and *Mimulus glaucescens*

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BIOL 672: Christopher Ivey

Previous studies have proposed that the *Mimulus guttatus* species complex may serve as a useful model for the study of rapid evolution. I studied reproductive isolation between populations of two of these species, *Mimulus guttatus* and *Mimulus glaucescens*, by comparing seed production following heterospecific and conspecific hand-pollinations. If postzygotic reproductive isolation contributes significantly to species barriers, reduced seed set in heterospecific crossings is predicted to be observed. No significant reduction of seed set was observed in between-species crosses relative to within-species crosses ($t = 0.1065$, $df = 7$, $P = 0.9182$ for *M. glaucescens* and $t = 1.1887$, $df = 6$, $P = 0.2795$ for *M. guttatus*), which suggests that postzygotic isolation via seed set imposes little barrier to hybridization between these taxa. As these taxa often coexist in nature without apparent

hybridization, other traits likely contribute toward maintenance of boundaries between these recently diverged taxa.

Stable isotope mixing models predict invasive species change feeding relations in Hawaiian stream food webs

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BIOL 672: Christopher Ivey

The presence of invasive species is a major factor determining community organization and function. Tracing stable isotopes of carbon and nitrogen through food webs is an important tool in understanding the impacts of invasive species in ecological communities. Isotopic signatures, coupled with stable isotope mixing models which estimate likely consumer food sources (% contribution), can illustrate feeding relationships, trophic niche space, and predict likely food sources of food web consumers. I hypothesize that isotope mixing model estimations, combined with isotope food web diagrams will illustrate (1) shifts in native consumer diets in highly invaded food webs, (2) illustrate novel predation relations between non-native and native consumers, (3) and illustrate diet overlap of native and non-native consumers who share similar niche space. Two streams on the island of Kaua'i, including Limahuli, a relatively pristine stream, and Kapa'a, an invaded stream, were sampled in March 2009. Tissue samples were collected from all food web members, analysis was conducted to determine carbon and nitrogen isotopic signatures, and a stable isotope mixing model, IsoSource 1.3.1, was employed to estimate potential food sources of consumers. Nearly seven times as many non-native consumers were present in Kapa'a stream food web compared to the food web of Limahuli in addition to another trophic level. In Kapa'a stream food web mixing model estimates demonstrated that eight non-natives consume the native shrimp, *A. bisulcata*, and 70.3% of a non-native turtle's diet (*P. steindachneri*) includes the native goby, *A. guamensis*. In addition, seven food sources contribute to the diet of *A. guamensis* in Kapa'a stream. In addition five non-native consumers have equivalent food sources, and on average 61.9% of the diet of *M. lar*, a non-native prawn, is *A. guamensis*. Stable isotope mixing model estimates illustrate that native and non-native consumers in invaded Kaua'i streams have high levels of food resource overlap, that native and non-natives may be directly interacting via predation on one another, and finally, natives may be faced with increased competition and predation pressures via increased non-native food web members.

Soil Disturbance and *Mimulus guttatus* Germination Success

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BIOL 672: Christopher Ivey

Interactions between plants and soils can be very complex. Soil disturbances can affect individual plants as well as entire plant communities. The object of this study was to gain better understanding of soil disturbance on seed germination rates in *Mimulus guttatus*. We acquired a total of eighteen 8 cm³ samples from approximately forty six meters from the intersection of Honey Run Road and Skyway on the left hand side of the road. We put six samples in three different categories consisting of soil disturbed then top seeded, soil undisturbed then top seeded, and seeded then disturbed. Each sample received twenty five seeds. The hypothesis that there will be an increase in seed germination rates in disturbed soils versus undisturbed soils was supported by the results. Our results indicated that there was a significant difference between disturbed top seeded versus undisturbed top seeded soils, with disturbed top seeded samples having approximately four times the mean number of seedlings than undisturbed top seeded samples. We believe the reason for

these results are due to increased soil to seed contact in disturbed top seeded samples, along with decreased soil to seed contact with undisturbed top seeded samples, due to plant ground cover.

Invasive Species Removal Results in Twofold Decrease in Growth Rate of a Rare California Endemic Plant

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BIOL 672: Colleen Hatfield

Although the negative effects of invasive plant taxa on native plant diversity are widely recognized, many details about these ecological interactions remain unknown. The effect of invasive species on rare native plant taxa is of special importance due to the precarious position many of these plants hold in their respective communities. In this research, we study the effect of invasive plants on the growth rate of the rare California endemic *Monardella douglasii* spp. *venosa*. In order to assess this interaction, we used a split plot design consisting of an invasive removal sub-plot and a control sub-plot. Invasive plant removal resulted in a significant twofold decrease in the growth rate of *M. douglasii* when compared to control plots. This result serves as an important step in understanding the complex relationships between native and invasive species and leads to further questions as to what effect this interaction may have on the reproductive fitness of rare plants such as *Monardella douglasii* spp. *venosa*.

Graduate Research (Thesis)

Analysis of rna22: A novel way to predict miRNA targets

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MicroRNA's (miRNA) have been recently recognized as key regulators of the translation of messenger RNA. A single miRNA has been known to repress multiple genes and given their short length, predicting these target genes has proven to be a challenge; especially since a miRNA can regulate a target by forming a heteroduplex of as little as 6 base pairs with the 3' untranslated region of the target mRNA. Rna22 has been introduced by its developers as an effective way to predict microRNA targets (Miranda et al. 2006). This study is aimed at testing the efficacy of rna22 by feeding in known targets of miRNA mir-375 as well as intergenic region where we presume no mir-375 targets exist. By examining the results of rna22's analysis we were able to see that rna22 correctly identified the known mir-375 targets while finding no potential targets in the intergenic region. Based on our finding we conclude that rna22 is an accurate way of finding potential new miRNA targets.

Vernal pool restoration for two rare grasses, *Neostapfia colusana* and *Tuctoria greenei*, at the Sacramento National Wildlife Refuge Complex

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Urbanization and intensive agriculture practice have resulted in the loss of vernal pool habitat throughout California, resulting in high numbers of rare species. Two examples of rare species endemic to California vernal pools are *Neostapfia colusana* (Colusa grass) – State Endangered and Federal Threatened - and *Tuctoria greenei* (Greene's tuctoria) – State Rare and Federal Threatened. The goal of this project is to increase viable populations of Colusa grass and Greene's tuctoria at Colusa National Wildlife Refuge and the Llano Seco Unit Management Area, both of which are part of the U.S. Fish and Wildlife Service's Sacramento National Wildlife Refuge Complex.

We will gather physical and biological background information on the restored (target) pools as well as reference pools that currently support extant populations of Colusa grass and Greene's tuctoria, to facilitate development of a reintroduction protocol based on physical conditions. The proposed activities will also include germination tests on Colusa grass and Greene's tuctoria seeds. Introduction of the two grass species (using seeds and seedling plugs) at the restored and reference vernal pools and weekly monitoring will document germination and survival through several early life stages. The results of this project will increase knowledge and guide restoration efforts for recovery activities for these species, as well as contribute to vernal pool restoration efforts in general.

Diversity and Distribution of Protists Surrounding a Thermal-acidic Lake

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Boiling Springs Lake (BSL) is a flooded fumarole that contains a 1.8 ha pool of pH 2.2, 52C water in California's Lassen Volcanic Park. It is a Microbial Observatory site focused on understanding the interactions among the entire microbial community. Little is known of food webs in such environments, but we hypothesized that low community diversity would reduce the complexity of trophic interactions. This study has aimed at revealing the diversity and biogeographical distribution of the grazing protists in and around this feature, as well as temperature and pH growth profiles for the primary organisms discovered. Using a culture-based genetic approach to estimate the function of the physical environment on diversity, we were able genetically fingerprint transect samples from the lake to the forest via denaturing gradient gel electrophoresis (DGGE) to investigate diversity based on SSU rRNA (V8 region). These results allowed us to construct group-specific primers for quick screening of samples. The results suggest the microeukaryotic grazing community, as assessed by genetic screens, is composed of a unique, endemic community in the lake and an increasing gradient of diversity to the surrounding forest. Our findings show that the near-lake environment is dominated by the heterolobose amoebagoellate *Tetramitus thermoacidophilus*, genetically similar but distinct to that found in Kapchatka and Italy (Baumgartner et al., 2009), that grows optimally at 40-50 C, pH 3. Samples further from the lake showed increasing diversity, yielding heterotrophic flagellate, *Bodo saltans*, the common soil amoebae *Acanthamoeba*, and *Hartmannella* spp.

Examination of the abundance, distribution, and diversity of reduced phosphorus oxidizing bacteria and their oxidation pathways in the environment

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Investigations into microbial oxidation of reduced phosphorus (RP) compounds (hypophosphite (Hpt) and phosphite (Pt)) suggest this activity is present in the environment. However, detailed investigations of RP oxidation (RPO) have been extremely limited. In two bacteria, the Hpt oxidation gene, *htxA*, is 100% identical. In three bacteria, the Pt oxidation gene, *ptxD*, is 50% identical. This study investigated the distribution and diversity of RPO bacteria in the environment and distribution and conservation of the previously characterized *htxA* and *ptxD* genes in environmental bacteria. MPN analysis of 12 environmental sites show bacteria capable of growth on Hpt and Pt are within $\pm 10^1$ the concentration on phosphate, showing their abundance in the environment. Hybridization and PCR reveal three isolates do not possess *htxA*, yet grow on Hpt, implying the presence of novel genes for RPO. Sequence analyses of *htxA* and *ptxD* orthologs from isolates show conservation with the previously characterized *ptxD* were 91-98% identical; orthologs of *htxA* were 80-97%. These data suggest novel *htxA* and *ptxD* orthologs exist in the environment and provide more evolutionary data for these genes. This study illustrates the environmental prevalence of diverse bacteria capable of oxidizing RP compounds; providing more evidence to suggest a significant role for bacterial RPO in

the environmental P cycle, an aspect that has been greatly overlooked. Genetic analyses show that while the previously characterized orthologs of *htxA* and *ptxD* are common, novel orthologs exist and these can aid in elucidating the evolutionary path of RPO genes, for which very little is known.

The Environmental Constraints of a Rare California Serpentine Endemic

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Many rare and threatened California plant species are endemic to ultramafic serpentine soils. Understanding what specifically makes these species rare is of high value to conservation and management efforts statewide. While there is no one definition of what makes a plant rare, there are many characteristics that are thought to contribute to a species' rarity. My study focuses on environmental and reproductive attributes of a rare serpentine endemic to evaluate their contribution to the plant's rarity. *Packera layneae*, or Layne's Butterweed, is a federally threatened and state listed rare species occurring in small, fragmented populations on serpentine soils in the northern California Sierra Nevada. I propose to evaluate environmental factors that define its restrictive habitat, including elevation, aspect, light availability and soil characteristics. I will collect data on these parameters in the field, which then will be analyzed and used in conjunction with geology maps and known associate species as inputs for a species distribution model. This model will be used to better understand this species' range as well as to predict potential undiscovered populations. I will also conduct experiments to evaluate the roles of dispersal limitation and soil chemistry as contributing factors to this species' limited distribution. Determining why this species is so patchily distributed and understanding its unique habitat requirements will be vital to its conservation and long-term success. This work will also contribute to our understanding of plant rarity and help guide management efforts.

Notes