

**FIFTEENTH ANNUAL
STUDENT RESEARCH
POSTER SYMPOSIUM**

**MAY 13, 2011
1PM - 4PM**

HOLT HALL

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

POSTERS

LOWER DIVISION CLASSES

Holt 227

UPPER DIVISION CLASSES, UNDERGRADUATE RESEARCH

Holt 225

GRADUATE CLASSES, THESIS RESEARCH

Holt 235

ENTOMOLOGY CLASS DISPLAY

Holt 235

ORNITHOLOGY DISPLAY

Holt 235

May 13

GREENHOUSES OPEN TO VIEW

10 am – 3 pm



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

2010 Brandee Stone

Lower Division Class Projects

LD-1

Determining a Predator's Behavioral Deterrence based on the Effects of Mimicry

Erick Leiz, Martha Montez, Ashley Van Buren

BIOL 152: Dr. Christopher Ivey

The design of the experiment is to develop a palatable mimic, a distasteful model, and influence the choice of a predator. There are 3 factors that influence the actions of the predator: 1) distastefulness of the model, 2) density of the mimic 3) the degree of related looks of the model and mimic. Over a three day course, this experiment was tested on a random group of birds present in our neighborhoods in the Butte county area. Sunflower seeds were soaked in distilled white vinegar to create the "distasteful" model. The sunflower seeds were dyed and divided into groups. We hypothesized that the model, the distasteful prey, will have an effect on the predator's behavior by discouraging the choice of prey that look similar to the mimic, based on color and taste. Towards the end of the research, we can gather an understanding of the behavior choices of the predators based on this experiment by collecting the data of prey that were removed. Two different random arrays for each site (total of 6) were set out on different days throughout the experiment. Data will be collected from the sites daily, and analyzed using a chi-squared. Overall data, Day 1 & 2, and Day 1 & 3 will be compared and graphed. At the end of the trial, if the majority of colors remaining are colored seeds, we can potentially conclude that our experiment has succeeded; the predator has learned to avoid sunflower seeds that look similar in color to be distasteful.

LD-2

The Effects of "eco- friendly" and "non-eco-friendly" laundry detergent on the growth of *Brassica rapa* Seedlings

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BIOL 152: Dr. Christopher Ivey

According to the Bidwell Park Final Management Plan, urban runoff reaching the Big Chico Creek, CA includes surfactants from laundry detergent. To investigate the possible effects of detergent on plants in Bidwell Park, two detergent types were studied. "Eco-friendly" detergent (Clorox Green Works HE) and "non-eco-friendly" detergent (Tide original scent HE) were used on *Brassica rapa* seedlings to study their effect on seedling height over a twelve day period. 72 *Brassica rapa* seeds were planted in 12 separate 6-pack planters. In each of the 6-pack planters there were two water treated seedlings (control), two 1% detergent treated seedlings and two 10% detergent treated seedlings. Six of the 6-pack planters were treated with "eco-friendly" detergent while six were treated with "non-eco-friendly" detergent. It was expected that "eco-friendly" detergent treated plants would grow taller than "non-eco-friendly" detergent treated plants for all concentrations and that control plants would grow the tallest. It was found that the 1% "eco-friendly" detergent treated plants (n=12) were taller on average than the 1% "non-eco-friendly" detergent treated plants (n=12) and both were shorter than their controls. 10% detergent treated plants of both "eco-friendly" and "non-eco-friendly" detergent did not grow. The results of this study indicate that although "eco-friendly" detergent may not affect plant height as much as "non-eco-friendly" detergent, it may still have a negative effect on plant growth when compared to plants not affected by detergent. Another finding of this experiment is that high concentrations of both "eco-friendly" detergent and "non-eco-friendly" detergent may prevent plant growth.

LD-3

Effectiveness of Batesian Mimicry based on Palatable and Unpalatable Prey

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BIOL 152: Dr. Michael Marchetti

This investigation was based on the idea that prey could escape capture from predators by means of mimicking an unpalatable prey. The main scientific question was if mimicry would indeed protect palatable prey from their predators. We began our study by creating palatable and unpalatable prey by means of sunflower seeds. Unpalatable seeds were previously coated in Tabasco sauce, but the palatable seeds were not. The seeds were dyed three different colors, each color with a different level of palatability. The seeds were arrayed onto separate trays and set outside for several days. Our results were that our predators had eaten all the seeds. Unfortunately, the predators had been cracking open the seeds to avoid the Tabasco flavoring. Hence our form of mimicry was not applicable to the intelligence we encountered by our predators. The significance of our findings proves that in order for Batesian mimicry to be a success, the mimic must portray a model that is completely unpalatable against intelligent predators. Otherwise, effective Batesian mimicry will not occur.

LD-4

Phenotypic Selection: Effects of Latex Production on Relative Fitness of *Taraxacum officinale*

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BIOL 152: Dr. Michael Marchetti

Latex is a common defensive mechanism against insect herbivores among plants, and is widely studied by biologists who aim to understand their effectiveness in protecting the plants that exude them. This experiment sought to identify the influence of latex production in the fitness of wild dandelions (*Taraxacum officinale*). Samples of dandelions were collected from both the public vicinities of Bedrock Park and the fields of the Riverbend Park wilderness. A comprehensive analysis was made comparing the plants' latex production to their flowering rates. The samples of dandelions were variable in both traits, and although the data did not show a strong preference for either extremes of latex production, a correlation can still be made between the amount of latex secreted and a plant's fitness. Data collected shows a positive correlation between standardized latex production and relative fitness in dandelions acquired from Bedrock Park, yet shows a negative reciprocal of these two traits in the dandelions from Riverbend Park, implying a difference in trade-offs resulting from insect predation in both environments.

LD-5

Phenotypic Selection in *Euphorbia peplus*

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BIOL 152: Dr. Michael Marchetti

Our team chose to investigate the phenotypic selection of latex in *Euphorbia peplus*. The purpose of our experiment was to determine the relationship between latex production and its fitness value. The hypothesis being tested is that plants with increased latex production will have lower fitness. This relative fitness value was determined by the proportion of damaged leaves observed on a plant in relationship to amount of latex produced. Studying this relationship showed us the strength and direction of selection for latex production in *E. peplus*.

Our method for this experiment was to first collect the *E. peplus* plants from the outside of Holt Hall on the CSU, Chico campus. After collecting the plants, we counted damaged leaves and total

leaves. Next, we measured the amount of latex production using 5ul capillary tubes. Finally, we measured above ground body mass using an electronic balance.

The results did not match with our predictions that increased latex production would have a slight to negligible effect on the number of damaged leaves and that relative fitness would increase as standardized latex production increases. A suggestion for future experiments includes testing *E.peplus* in its natural environment to potentially give more accurate results due to presence of natural predators.

LD-6

Point-Centered Quarter Analysis of Local Chico Tree populations: Basal Area and Relative Density

Sidney Adams, Greg Alire, Cola Knight, Philip Reilly, Heidi Rogers, Surinderpal Sarai
BIOL 152: Darhl Whitlock

Accurately estimating specific tree populations and density within topical regions is an important aspect of understanding their contribution and importance to the local wildlife community (Mitchell 2007). In this study the point-centered quarter method, traditionally used by forestry departments, was implemented to compare the basal area and relative density of local tree populations at 5-mile and the Big Chico Creek Ecological Reserve. In both locations five plots consisting of twenty total samples were measured for basal area at breast height including the distance from the initial point within the plot for a relative density calculation. Analysis using an independent samples t-test indicated there was no significant difference in basal area ($T = 0.481$, $p = 0.63$), or relative density ($T = 0.025$, $p = 0.98$) between 5-mile and BCCER.

LD-7

Effect of population density on relative fitness (flower number) of *Euphorbia peplus* in Lower Bidwell Park in Chico, California.

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BIOL 152: Darhl Whitlock, dwhitlock@mail.csuchico.edu

Flowers are a tool used by many plants for pollination. However, it takes energy and resources to produce each flower. A previous experiment described the relationship between population density and plant size. The results state population density increases, plant size also increases (Enquist, Brown, West, 1998). So, does population density have an affect on relative fitness (flower number)? The main problem in this experiment is if population density has an effect on the number of flowers produced by *Euphorbia peplus*. The null hypothesis for this experiment is that population density will have no effect on the flower number in *Euphorbia peplus*. The alternate hypothesis is that, as population density increases the relative fitness (flower number) will also increase in *Euphorbia peplus*. Six 1 foot by 1 foot plots containing various amount of *Euphorbia peplus* in Lower Bidwell Park were identified and the numbers of flowers on each plant were counted. Some of our data included a plot containing one plant where there was an average of 85 flowers per plant and a plot containing six plants showed an average of 28.8 flowers per plant. After performing an ANOVA test the p-value was .02, therefore the null hypothesis that population density has no effect on flower number can be rejected.

LD-8**Fitness of *S. Lycopersicum* As Measured By Plant Growth in Response to Different Water Treatments**

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BIOL 152: Dr. Christopher Ivey

This experiment was conducted to test the fitness of the tomato plant (*Solanum lycopersicum*) as measured by plant growth when exposed to different water treatments. The study investigated whether the different water treatments; salt water, tap water, or deionized water affected the rate of growth. This study was conducted by watering each separate sample plant with 75mL of the prescribed water treatment every other day. Data was collected every 5 days which included measuring the growth of the plant in centimeters. It was hypothesized that the deionized water would allow for maximum growth rate due to the fact that it was free of impurities and that salt water would not allow for maximum growth rate. The results of this experiment showed that there was no statistical difference in the rate of growth between each prescribed water treatment. Based on our results from this experiment, fitness as measured by plant growth was not found to be affected by water treatment.

LD-9**Decomposition rate differences due to microbial activity in Big Chico Creek**

Kerry Poole, kpooles2@mail.csuchico.edu; La Lor, and Jordan Yingling

BIOL 152: Dr. Christopher Ivey

Water has been shown in many studies to be a big proponent in erosion and deterioration to natural substances. The concern for this study was about components that may be in a source of water that would lead to faster decomposition of an organic substance. Slices of meat were placed into jars of fresh water from Big Chico Creek and jars of water containing tap water from the Chico Area to see the different rates of decomposition. Microbes in the Big Chico Creek water were believed to cause a faster rate of decomposition than that of the Chico City tap water. The microbial levels were not calculated but previous research showed specific types to be present. Results were calculated to show an unexpected difference in decomposition levels. Sample size was limited to 4 pieces per test group which may have led to inaccurate results. More research could be done to test what specific differences in the two samples of water caused different rates of decomposition.

LD-10**Genetic Links and Environment in California Lizards**

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BIOL 152: Dr. Christopher Ivey

Using genetic data rather than just morphological and habitat to create phylogenies creates a better understanding of how a certain organism has developed over time, and from what. Lizards living in different habitats share many genetic similarities with lizards of the same species but with change in habitat a change in genetics could be expected. This coding to adapt to other habitats and styles of survival should lead to some lizards of different species being related genetically due to the environment in which they live. By sequencing at 12s rRNA segments of many different species of lizards in California together a phylogenetic tree can be created using software. Boot strap testing then can be used to better check the sequences for overall percentage of likelihood. Lizards of the same species and genus are the closest related but also may have been linked environmentally in the beginning. Habitats have changed over time and some lizards in the same species have moved while others stay, showing in what habitat the lizard came from. Other species of the same original habitat will end up being closely related. Significantly showing that a particular species of California lizard

developed in one particular habitat and moved but did not genetically adapt to the habitat where it has moved.

LD-11

Tests of Optimal Foraging Theory in *Sciurus griseus*

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BIOL 152: Dr. Christopher Ivey

Optimal foraging theory suggests that animals try to maximize their net energy intake per unit of time, and when given a choice the preference will be towards more nutritious foods. Western gray squirrels (*Sciurus griseus*) prefer a diet of seeds and nuts with high oil contents as their primary energy source. With this information, we aimed to test whether there would be a preference for high fat nuts when made available alongside less nutritious, but easier to access foods. Our hypothesis was that squirrels would choose the food that gave the highest energy benefit, and by weight, more of this food type would be taken in the allotted time. To test this hypothesis, trays containing two food types were set out at a known feeding location. The squirrels were presented with two different food options in each pan, 100 g of pecans in the shell (approximately 13 whole pecans), and 25 g raw pumpkin seeds. The food was made available for twenty reps of 30 min, the weight of both food choices was recorded after each half hour, and the final data was compared using a T-test. In pecans, the mean percentage removed after half hour was 11.05%, compared with 13.4% for pumpkin seeds, with standard deviations of 20.4 and 20.6 respectively. With a T-crit of 0.3625 at 38 degrees of freedom, and a P-value of 0.72, the null hypothesis could not be rejected because the probability was greater than 0.05, indicating that the squirrels preferred the easier to access, though less nutritious food.

LD-12

Impact of Moisture on Stomatal Density in Green Leaf Manzanita (*Arctostaphylos patula*)

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BIOL 152: Darhl Whitlock

Stomatal density was measured between Green Leaf Manzanita plants (*Arctostaphylos patula*) in both a moist and dry environment. Moist and dry environments were characterized by Manzanita plants less than 20 meters and farther than 1500 meters from a water source, respectively. It was hypothesized that the Manzanita leaves in dry environments, far from a water source, would have fewer stomata to reduce water loss. The null hypothesis was that no statistical difference could be seen between the two environments. A total of forty stomata print samples were analyzed under a compound microscope from leaves collected in Upper Bidwell Park. The mean stomatal density of the plants in the moist environment was 13.95 stomata per 0.12mm² of leaf. The mean stomatal density of the plants in the dry environment was 13.85 stomata per 0.12mm² of leaf. Statistical analysis calculated the t-value to be 2.02, P value as .928 and a degree of freedom at 38. Because the P value was larger than .05 we cannot reject our null hypothesis of no difference between the two environments.

LD-13

Stomatal Density of *Sambucus nigra* with Varying Access to Water

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BIOL 152: Dr. Christopher Ivey

We are looking for a correlation of stomatal density with varying distances from water in the California native plant, *Sambucus nigra*. This correlation would demonstrate the biological principle of phenotypic plasticity, and how changes in the environment or amount of readily available resources can affect the plant phenotypically, in terms of stomatal density. Our experimental hypothesis was that plants which were farther away from a water source would have a lower stomatal density due to attempted conservation of water loss. We analyzed the stomata in multiple areas of each leaf using compound microscopes. Using the ANOVA statistical test, we got an f-crit of 3.2 and a P-value of 3.46E-05, which support the hypothesis that there is a significant difference. Interestingly though, we found the opposite of what we thought to be true in that leaves farther away from water had more stomata, not less. The significance of this experiment is that it demonstrated a noteworthy change in the density of stomata in the leaves. This principle of phenotypic plasticity leads us to conclude that the access to water may have an effect on the relative fitness of the plant. We would like to further this experiment in the future with a greater number of plants to see if the correlation is indeed due to access to water.

LD-14

An investigation into the correlation between trichome density and reproductive fitness and the response to environmental factors in *Amsinckia menziesii* var. *intermedia*

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This investigation was carried out to assess the correlation between trichome density and relative plant fitness in the species *Amsinckia menziesii* var. *intermedia*, as well as to determine whether or not climate or amount of human disturbance has a significant effect on the selection pressure of the traits. Upon initial consideration, we hypothesized that there would be a strong negative relationship between trichome density and reproductive fitness as a result of metabolic trade-off, and that climate and human disturbance would play a significant role in the selection pressure of trichome density, thus affecting *A. menziesii*'s reproductive fitness, assuming that the first hypothesis holds true. The way in which these hypotheses were tested was by collecting data from two distinct sample sets differing in elevation, climate, and frequency of human interaction several miles apart (so as to eliminate any possibility of cross-pollination). Upon analysis of the data collected, our first hypothesis that the metabolic trade-off of high trichome density would result in lowered reproductive fitness was supported ($p < .01$), although there was no significant difference in selection pressure between the two environments ($p > .05$), thus disproving our second hypothesis. These results showed that human presence and environmental conditions don't significantly affect the fitness of the plant, contrary to what common sense may lead one to expect. They also raised the question of why trichomes persist despite being a detriment to reproductive fitness.

LD-15

Varying Levels of Human Disturbance Found to Have No Effect on Insect Diversity Along Big Chico Creek after sampling populations at Upper Bidwell Park, Lower Bidwell Park and on CSUC Campus

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This experiment was conducted to further understand the impact of varying levels of human disturbance on three different locations along Big Chico Creek had on insect diversity. Human disturbance was measured by estimating foot traffic at different locations with the largest amount of disturbance on campus and the least at Upper Bidwell Park. The study investigated; whether or not three varying microclimates affected insect species diversity along the Big Chico Creek, and whether or not distance from the creek shore in the varying locations also had affected species diversity. This

study was conducted by setting out arrays along Big Chico Creek in Upper Bidwell Park, Lower Bidwell Park, and on campus which constituted as microhabitats. Arrays were established by burying cups so that the rim was level with the soil, each sampled three distances from the creek, each three meters apart this established a microhabitat. A soap-water solution was poured into the cups in order to capture any fallen insects. The arrays were then left undisturbed for one week. Cups were then collected, and the insects they contained sorted and scored in accordance to like species. The results of the experiment yielded a p-value of 0.6893 in response to habitat selection and a p-value of 0.1701 in response to micro habitat. As the p-value results were significantly $>p=0.05$, we accepted the null hypothesis; microhabitat and microhabitat do not impact species diversity. Based on results found in this experiment, species diversity was not found to be impacted by microclimate and microhabitat along Big Chico Creek.

LD-16

Plasticity of Height vs. Latex Production in *Euphorbia Peplus*

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BIOL 152: Christopher Ivey

The significance of the research that my partner and I conducted was to investigate Phenotypic selection in *Euphorbia Peplus*. We tested the strength of selection of two traits within the plant which was height and latex production. It will help us discover the potential for evolution of height and latex production in later generations. Our experimental hypothesis is that latex production will have a higher strength of selection than height when we measure the traits against their relative fitness. This is because latex production is used as a defense mechanism against herbivory which results in a trait that is more desirable by the plants. We collected multiple samples of random size and measured height with a ruler and latex production with microcapillary pipettes. We then calculated the relative fitness for each plant and compared it to the traits that we chose. We calculated the standard trait value for height and latex production in every plant. We used a linear regression to estimate the selection for both traits. Our results showed strength of selection of 0.0093 for height and -0.0535 for latex production. There is a slightly positive correlation between relative fitness and height, but a negative correlation for latex production. We can use this to better understand the effectiveness of latex production on the relative fitness of the plant compared to the height of the plant.

LD-17

Examining Subterranean Species Richness At Various Distances From Big Chico Creek In Lower Bidwell Park

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Alluvial soil frequently contains a mix of highly nutritive granular material known as silt due to the erosion, deposition, and stratigraphic superposition of sediment. Because of the confluence of silt and water at the edge of the river, one might expect a higher level of annelid density near the shore of a creek, relative to the biomes around it. The shores of Big Chico Creek in Bidwell Park represent an ecotome, an area of ecological transition where two biomes, the river and the surrounding foliage, meet. Due to this confluence of biomes, one might expect greater species richness. In addition, the river's current, and its erosion of the soil on the shore, might induce enough disturbances into the ecotome to vacate various niches in the alluvial environment. A study of relative annelid density in relation to distance from Big Chico Creek is reported here. Soil samples taken at 5 feet and 150 feet away from the creek demonstrated that species richness of annelids decreased commensurate with distance from Big Chico Creek. Using a shovel, soil samples six inches

in diameter and 4 inches in length were excavated and sifted through in a plastic tub at 10 different locations at varying distances from Big Chico creek. Manual examination of the samples yielded total annelid density. Silt, productive disturbance by the river's current, and the confluence of biomes on the shore of Big Chico Creek may all be contributing factors to the apparent increase in annelid density that our experiment demonstrated.

LD-18

Island Biogeography

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Andrew@vaskos.com

BIOL 152: Dr. Christopher Ivey

Island Biogeography explains species richness in communities specifically islands. Species richness is determined by immigration and extinction rates. In our experiment, we wanted to figure out the relationship between island size, distance from the mainland, and species diversity over time. We predicted that immigration would be more prevalent in islands closer to the mainland and larger area. To test this, we blindly threw five trials of poker chips for 30 seconds into five different sized islands from a constant mainland point. This represented immigrating species from the mainland to new islands. This experiment then demonstrated the number of relative to island size and distance from the mainland. Our data showed that the largest island had the most animals at the end of the experiment. The island that was the closest to the mainland had the most animals on it after the first trials. This showed immigration took a few generations to repopulate the islands. We also found that lower trophic levels arrived and established themselves first. Then, the upper trophic levels followed by inhabiting the island in small numbers. We also found that species richness increased quickly in the first immigrations and then there was a higher percentage of extinction after animals were already on the islands. These observations lead us to conquer with the theory of island biogeography.

LD-19

The Effect of Varying pH Levels on Trap Closure Rates of *D. Muscipula*.

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BIOL 152: Dr. Christopher Ivey

This experiment was conducted to test the effect of solution pH on the rate of trap closure on the plant *D. Muscipula*. We investigated whether plants fed with one of three pHs would have a change in the rate closure for an individual trap on that plant. Our experiment was conducted over a period of approximately a week and half, during which the plants were fed a designated solution (either slightly acidic, slightly basic, or neutral). The traps were induced to close every couple of days, while we recorded the time it took for this to occur. The results of the experiment show with a p value of .02, that there was a significant alteration in the trap closure rates for our neutral plants but ultimately for the acidic and basic treatments there was no significant change in the rate of closure. The findings of this experiment are significant because they the first step in beginning to understand the effect of pH change in rain on *D. Muscipula*.

LD-20

Allelopathy Exhibited by *Juglans nigra* Inhibits Growth of Germinated Seedlings

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BIOL 152: Dr. Christopher Ivey:

Allelopathy, the chemical interaction in which one plant inhibits the germination or growth of another plant, has been widely studied in biology, because it provides information that is useful in

both agriculture and ecology. *Juglans nigra*, commonly known as the black walnut tree, is one species that has been known to prevent the growth of plants in nearby areas through the secretion of a toxin called juglone. When exposed to this allelochemical, plants often exhibit symptoms such as wilting, chlorosis, and death. This experiment, through the use of a juglone extract, investigated the effects of this potentially allelopathic species on germinating lettuce seeds. It was hypothesized that *J. nigra* is effectively able to inhibit the growth of young seedlings, because juglone prevents respiration in growing plants. The juglone extract was created by soaking crushed *J. nigra* leaves in water, and was then used to moisten the soil that contained the seeds. After two weeks, the average plant height was measured and was compared to the control, which contained activated charcoal to absorb the juglone. Through the use of a t-test, we were able to conclude that juglone effectively inhibits the growth of young seedlings. Although not all plants are affected by allelotoxins, these results suggest that *J. nigra* is able to prevent the growth of nearby plants, thereby allowing them to outcompete other species for necessary resources.

LD-21

The direct relationship between increasing fruit size and higher stomatal densities.

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BIOL 152: Dr. Christopher Ivey

In the project, the goal was to find if there was a relationship between the stomatal density of plants and the size of their fruit. In the research collected, the data showed that there was a positive trend between the stomatal density and the fruit mass. Our hypothesis was that we would find a trend that showed that as the fruit size increased, so would the stomatal density. The carbon used in the building carbohydrates by the process of photosynthesis, to create fruit, is taken from the carbon dioxide in the air and oxygen is produced as a waste product. Thus a plant that generates bigger fruit would use more reactants and produce more waste and an increased number of stomates would improve the plants efficiency because they are the site of gas exchange between the plant and the environment. 52 leaf samples were collected from different trees of varying fruit sizes. Then imprints were taken from the bottoms of the leaves. The imprints were achieved by applying clear nail polish to the underside of the leaves, allowing it to dry, then sticking clear packing tape on the dry nail polish and gently peeling it off. Then the tape with the imprint was put on slides and then observed under a light microscope at 400x power. The numbers of stomates were counted and the data was collected and put on Excel. According to the data the stomatal density did increase as fruit size increased. For example, California poppy which had tiny fruit had a stomatal density of 10 and a lemon tree which produces larger fruit had a stomatal density of 162.

LD-22

Decrease in Stomatal Density of Japanese Maple (*Acerbica Palmatum*) with Decrease in Light Intensity of the Leaf

Raveena Dhami, rdhami@mail.csuchico.edu; and Sumanpreet Ojla, sojla@mail.csuchico.edu

BIOL 152: Christopher Ivey, ctivey@csuchico.edu

Greater stomatal density increases a plant's potential for control over water loss rate and CO₂ uptake. It is known that leaves exposed to sunlight have a greater stomatal density than leaves that are not exposed to the sun, so the question is if a leaf's color has any relation to stomatal density. The hypothesis to be tested in this experiment is whether or not a difference in the color of a leaf from a tree that is exposed to direct sunlight, has any effect on stomatal density. In order to conduct this experiment, some leaves of a Japanese Maple were gathered from a tree on Chico State's campus. Both green and red leaves that were exposed to sunlight from this tree were collected. Using a scientific microscope the stomatal density was gathered for each of the leaves. Amongst the red leaves there is a greater light intensity than those of the green leaves. The red leaves of the

Acerbic Palmatum have greater stomatal density than the green leaves. It was determined that the color of leaves do have a relation with stomatal density.

LD-23

Effect of Fertilizer on Green Chop of Radishes

Elyse Ferchaud, Nickolaus Crippa, Kirsten Westwick
BIOL 152: Dr. Christopher Ivey

Fertilizer and seeding density are two important aspects to the agriculture industry, and both have ability to affect productivity and carrying capacity. Understanding carrying capacity of the land and the effects of nitrogen fertilizer is an important concept for all. Carrying capacity refers to the number and size of individuals that an ecosystem can support (Carrying Capacity). Developing an understanding of proper seeding and nitrogen amounts can be beneficial economically, as well as environmentally. Growing radishes in separate containers, each with different seeding densities and fertilizer amounts simulates real-life situations in radish production. Seeding densities and fertilizer amounts should produce varying weights of green chop. In the experiment, 16 containers were filled with potting soil and either 0, 50, 100, or 200 Kg/H of fertilizer. These were then divided into being seeded with 25, 50, 100, or 200 seeds. The seeds were grown for 3 weeks, and green tops were cut at ground level and weighed. The data was added into a table. Analysis of the radish growth of the radishes shows that while data does not statistically vary regarding seed density ($p = 0.68$), fertilizer treatment does affect green chop ($p = 0.04$). Radishes also began to form at the seeding densities of 25 and 50, indicating that overcrowding of seedlings negatively affects production.

LD-24

Survival of Artificial Aposematic Prey After Being Attack by Chico's Native Birds

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BIOL 152: Dr. Christopher Ivey

Many inedible insects are aposematic, vibrantly colored; this had been as a seen as a signal for predators. It seems as today predators have learned to distinguish between edible and inedible prey by sampling and sacrificing one or two individuals (Jarvi). In our experiment we want to investigate the theory of mimicry with color variation, and whether or not aposematic coloration will protect our prey from predators. To test this idea we set up an experiment that consisted of preys that were made up of sugar cookie dough mix with red and green food coloring. The response of local birds on the color variation and whether frequency dependence can predict protection levels between the two groups of prey, evaluating data collected from four arrays containing fifty preys, which were randomly placed. The hypothesis that preys that have aposematic coloration would be more protected was not supported in our experiment. In contrast, the prey with aposematic coloration had the highest frequency of being removed and least protection.

LD-25

Stomatal Density: Comparisons Between Distances from Big Chico Creek in Upper Bidwell Park

Kaleb Fitzgerald and Shanon Buckhold
BIOL 152: Dr. Christopher Ivey

Conduction of the relationship between stomatal density in *Quercus Lobata* (Valley Oak) and the amount of ground water available to *Q. Lobata* through soil moisture. Experiment implies that the farther away *Q. Lobata* is from Big Chico Creek in Upper Bidwell Park should have a decreased stomatal density within their leaves. The availability to water should have an impact upon the *Q. Lobata's* plasticity to produce stomata. Stomata are important for the plants ability for gas exchange,

which is the determining factor in both photosynthesis and transpiration within *Q. Lobata*. After examination and statistical calculations, it is indicated that the stomatal density varies among the *Q. Lobata* and their availability to ground water through soil moisture, as well as their ability to perform photosynthesis depicted upon *Q. Lobata's* size and growth.

LD-26

Melissa Clark, Maureen Isbell, Kristen Omi, Matt Salomon

BIOL 152: Rick Wittsell

Stomata are the pores used for gas exchange in plants. When open, the stomata release water and allow CO₂ to enter for carbon fixation. The purpose of this experiment was to examine if stomatal density differs in trees that were constantly watered vs. trees that were intermittently watered. Leaves from California Buckeye (*Aesculus californica*) were collected from two trees located on campus, and two trees located in Upper Bidwell Park. Imprints of the leaves were made and placed on slides, and then the numbers of stomata in the field of view were counted. Averages were found (Tree 1 = 375.4 mm⁻²; Tree 2 = 207.9 mm⁻²; Tree 3 = 318.8 mm⁻², Tree 4 = 260 mm⁻²). An unpaired t-test was then performed on this data ($t = 0.892E-01$, $df = 78$, $p = 0.28$). Based on the t-test results, our alternate hypothesis that trees that were constantly watered had more stomata per mm than trees that were intermittently watered was rejected. These data suggests that there is no significant difference in the number of stomata in the leaves between the two watering treatments. In order to improve upon this experiment, it would be necessary to have a larger sample size. This would be done in an attempt to achieve a more significant p-value.

LD-27

Comparison of species diversity in creek and upland habitats along Big Chico Creek at Upper Bidwell Park

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BIOL 152: Rick Wittsell

Species diversity was examined at two different environments along Big Chico Creek at Upper Bidwell Park to better understand the importance of habitat variation. Our experimental hypothesis stated that species diversity would be greater among the creek habitat compared to the upland habitat. Together, there were 6 tested sites, 3 from the creek habitat and 3 from the upland habitat. One study site was < 3 m from the creek, considered the creek habitat. The other was measured at 5 m from the creek test site; this was called the upland habitat. After laying down a 3 m x 3 m transect, we counted the amount of species present, as well as the number of individuals of each species. With this data, we employed the Shannon Weaver Index to measure species diversity and to determine which location contains the highest species diversity. Our results suggest that although there appeared to be a visual difference, the data lacked statistical confirmation. Therefore, these data suggest there is no significant difference ($p > 0.26$) between species diversity in creek and upland habitats and further studies are necessary at this location.

LD-28

A.Briggs, S.Gillam, J.Lengerich, A.Neligh, and I.Scott

BIOL 152: Rick Wittsell

This experiment was pertinent to those in the agriculture industry who are working to increase their profits by keeping the costs of production at a minimum. To study the effects of seed density and fertilizer concentration on the biomass of the radish plant, an experiment was conducted where radish plants were grown and the seed density and nitrogen concentration in the fertilizer were varied. The radish plants were divided into four groups of four plots, each plot was assigned a different amount of seeds. Each group had varying levels of nitrogen concentrations in the fertilizer.

From the experiment it was found that an increase in nitrogen concentration did increase the amount of radish biomass, was significant ($p < 0.05$). There was also a significant difference in the seeding densities ($p < 0.05$). However, there was not a significant interaction ($p > 0.09$) between the seed density and nitrogen concentration among the plots. These results suggest that in an attempt to increase yield of the radish crop, one could use the maximum number of seeds and a fertilizer with a higher nitrogen concentration.

LD-29

The Effect of Soil Moisture on Stomatal Density in Manzanita

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BIOL 152: Rick Wittsell

Stomatal density is an important regulator of water loss and temperature control for plants. By developing more drought resistant varieties and creating plants that can survive outside their optimum climate, food crops can produce better yields. The primary purpose of this investigation was to identify if there is a difference in stomatal densities in leaves that were found on common manzanita, (*Arctostaphylos manzanita*), plants in dry or moist soil in a seasonally xeric chaparral community found in the rain shadow of the Coastal Range Mountains of Northern California. The group expected to see higher stomatal density in leaves found on plants in dry soil because it would be important for those plants to conserve water. Three leaves were taken from five different plants found growing in dry soil and three leaves were taken from five different plants in moist soil. Microscopic analysis of stomatal density was performed on leaves. The density was then calculated according to the sample area. A t-test was performed using the two means of 51.85 stomata/mm² and 61.85 stomata/mm², ($t = 0.083$, $df = 28$, $p = 0.08$). These data suggest that there are no significant differences in stomatal density between leaves found on common manzanita plants in moist soil and leaves found on common manzanita plants in dry soil. However, at $p = 0.08$, a larger sample size results may be significant.

LD-30

Regression Analysis of Latex Production with Reproduction Fitness for the Biologic Control of *Euphorbia peplus*

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BIOL 152: Rick Wittsell

Biological control of the genus *Euphorbia* has been studied in some areas of the United States. Success rates were varied with location. Evaluation of the susceptibility of *Euphorbia peplus* to biological control was evaluated using regression analysis. Latex production was measured by removing a leaf and collection exudate with a micro-capillary pipet. Reproductive structures and number of damaged leaves were counted on 34 plants randomly selected from a large population. Standardized latex production was compared to proportion of damaged leaves by regression analysis. Additionally, a regression was performed comparing standardized latex production with relative fitness. Damage was negatively correlated with latex production ($R^2 = .085$). Latex production was positively correlated with relative fitness ($R^2 = .009$). Damage from herbivory was correlated with higher levels of latex. The results also suggest there was a correlation between latex production and relative fitness with an increase in latex production being positively correlated with an increase in relative fitness. Control of *E. peplus* with a biologic agent present in the environment studied may not be the best choice. If latex production is a phenotypically plastic trait, a biologic control may be counter indicated because an increase in latex production may result in increased fitness.

LD-31

Stomatal Density in *Umbellularia californica*

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BIOL 152: Darhl Whitlock

Stomata are pores located on the underside of a leaf that open and close to allow gas exchange with the help of a pair of guard cells. To gain insight into the mechanisms regulating stomatal density, *Umbellularia californica* commonly known as California bay, was examined. The stomatal density per .12mm² of twenty-five shaded leaves was compared to twenty-five leaves exposed to direct sunlight to see if there was a significant difference. The results of the experiment was the acceptance of the null hypothesis that there is no significant difference in stomatal density in the sun and shade, based on a calculated t value of .075456, a t critical of 2.09, 24 degrees of freedom and a p-value of .05. We suggest that both environmental and physiological factors combined contribute to stomatal density.

Upper Division Class Projects

UD-32

Characterization of Bacteriophages Isolated from Sewage

Samantha Barrera-Gomez, Lyndsey Burescia, Olga Cooksey, Lisa D'Amico, Blaire Dernbach, Brittany Duch, Allyson Erlendson, Garrett Granger, Gurjinder Kalay, Cola Knight-Salicka, Yer Lee, Kyle May, Jaimee Olson, Brittany Ordez, Cheyne Rogers, Mandeep Singh, Tara Sprague, Samantha Steadman, Jagdeep Thiara, Nicholas Yorton
BIOL 476 (General Virology): Dr. Larry Hanne

The objective of our study was to analyze several different characteristics of bacteriophage (phage) that infect various bacterial hosts. As a class we isolated phage from raw sewage that can infect *E. coli* strain B, *E. coli* strain ML30, *E. coli* strain C91, *Pseudomonas aeruginosa*, and *Serratia marcescens*. Our analysis revealed that most of the bacteriophage were host specific, meaning they could only infect one host. However, bacteriophage infecting *E. coli* were capable of infecting multiple strains. All of the phage could survive 60 C for 15 minutes, except *Serratia* phage which could only survive up to 40 C. Burst size of the phage varied from 45.9 to 71.2. Three of the six phage were shown to follow single hit kinetics; data from the other 3 phage was inconclusive. The genome size was determined for 2 of the 6 phage. The C91 phage genome was approx 28 kbp and the *Pseudomonas* phage was approx 20 kbp. SDS-PAGE from most of the phage tested showed two major proteins (likely capsid proteins) of 45 to 60 kdal. We found that none of the phage were enveloped. Attachment studies were also conducted. These characteristics will help us gain a better understanding of phages and their hosts that reside in raw sewage.

UD-33

Reduced pollen germination in heterospecific crosses between *Mimulus guttatus* and *M. glaucescens*

Daewan Ha and Zachary Baroni
BIOL 369: Dr. Christopher Ivey

In the *Mimulus guttatus* complex, relatives of *M. guttatus* have been identified, yet we do not know how all of these are reproductively isolated from each other. Using *M. glaucescens* and *M. guttatus*, we experimentally determined whether *M. glaucescens* was reproductively isolated from its progenitor through germination. As a result, we found that the germination percentages of

conspecific crosses were 24% greater than the heterospecific crosses. The difference of germination successes for heterospecific pollinations keep the two species reproductively isolated.

UD-34

Ovule preference in *Mimulus glaucescens* and *M. guttatus* is not a mechanism of reproductive isolation

Matthew Lane and Kristina Short
BIOL 369: Dr. Christopher Ivey

Reproductive isolation in *M. guttatus* and *M. glaucescens* is evident in the minimal hybridization observed in sympatric growth locations. It is likely that a large portion of this reproductive isolation takes place at a single barrier in the fertilization process. Interactions between ovules and pollen tubes are not necessarily well-understood; however, if there is a reproductive isolation barrier present in this stage, the effects should be observable when this stage of development is experimentally isolated. Procedures for isolating this stage and determining the presence of a barrier are presented. Results indicate that there is no preference for con- or heterospecific ovules, suggesting that the reproductive isolation mechanisms present between the two species are located elsewhere.

UD-35

Conspecific pollination between *Mimulus glaucescens* and *M. guttatus* does not confer a higher pollen tube growth rate over heterospecific pollination

Jordan Stambaugh
BIOL 369: Dr. Christopher Ivey

Reduced seed set was found in hybrid crosses of *Mimulus glaucescens* and *M. guttatus*, which may be attributed to prezygotic isolation. One of these prezygotic barriers is difference in pollen tube growth rates between the two species, which may or may not be slower with heterospecific pollination. To test this hypothesis, both conspecific and heterospecific hand pollinations were done for *M. glaucescens* and *M. guttatus* and the amount of time it took for a pollen tube to emerge from the severed style was recorded to get the PTGR (in mm/min) and the rates were compared using ANOVA, but there turned out to be no difference in germination rate between species of between conspecific or heterospecific crosses. We concluded that there was no reproductive isolation due to pollen tube growth rates in conspecific vs. heterospecific crosses of the two species.

UD-36

Gene Expression of AT4G21960 in *Arabidopsis thaliana*

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BIOL 409: Dr. Kristopher Blee, kblee@csuchico.edu

The small plant *Arabidopsis thaliana* is a model organism, containing 73 class III secretory peroxidases genes. These peroxidases are thought to play a role in lignification of plant cell walls through production of phenolic radicals. We questioned whether the peroxidase gene AT4G21960 was found in lignified cells and where it was expressed in *Arabidopsis*. Using bioinformatics tools, we determined that our gene was expressed at high levels in the root. We hypothesized that our gene would primarily be expressed in epidermal atrichoblast cells at the zone of expansion, near the root tip. Based on this, we designed primers to isolate our gene, constructed to include a yellow fluorescent protein. After isolating our first round TT-PCR products from DNA and assembling our

gene construct using TT-PCR, we cloned it into the plasmid of competent *E. coli* cells. These cells were cultured and the plasmid was isolated. The plasmid was subcloned into a second plasmid and used to transform *E. coli* cells. The binary vector subclones were isolated and used to transform *Agrobacterium tumefaciens* cells. These cells were then used to transform *Arabidopsis thaliana* plants. The seeds from these plants were grown and the roots of the offspring were analyzed under a fluorescent microscope for the yellow fluorescent protein, attached to our peroxidase. Our results show that the peroxidase was present and we conclude that our peroxidase gene AT4G21960 is expressed in the root. Based on our data, we predict that other peroxidase genes may be expressed in lignin containing cells.

UD-37

A. *thaliana* reporter-construct formation for the class III peroxidase gene At2G38390

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The Class III Peroxidase gene family of *Arabidopsis thaliana* contains enzymes that are hypothesized to be involved in catalyzing the formation of monolignol radicals that are necessary for the creation of lignin. Lignin is an important polymer that aids in waterproofing and protection against pathogens. In this study we sought to make a genetically engineered construct containing a native peroxidase gene with a YFP label. We predicted that through the use of tri-template PCR we would be able to construct our gene At2G38390 with a YFP marker. Using bioinformatics we determined a suitable insertion site for our YFP. We then used PCR to amplify fragments around this insertion site. The PCR products were used in a ttPCR reaction to create our YFP-labeled gene construct. The resultant construct is of the correct size, 3400bp, which is the sum of the sizes of the three fragments we fused. This was determined by gel electrophoresis. The ttPCR product will now offer us a labeled gene whose localization we can track by transformation of *A. thaliana*. Additional future work could also include altering plant growing conditions. We could grow *A. thaliana* in stressful conditions that would stimulate increased peroxidase expression for our gene and determine this difference in expression through RNA quantification of the differentiated tissue.

UD-38

Expression and Characterization of AT4G21960 in *Arabidopsis thaliana* by Fluorescence Tagging

Kyle May, Dustin Rollins, and Eric Hankins
BIOL 409: Dr. Kristopher Blee

Not a great deal is known about the cellular expression of the peroxidase family of proteins in *Arabidopsis thaliana*. Our experiment was aimed at characterizing the levels of expression and location of the AT4G21960 protein within various tissues of *Arabidopsis thaliana*. Based on a heat map generated by Genevestigator from our gene sequence we predict our gene to have a high level of expression in tissues such as roots, stems and leaves, localized toward the cell wall. PCR was done in order to amplify our peroxidase gene with a YFP (yellow fluorescent protein) sequence in the C-terminal end of our protein two amino acids downstream from the last cysteine residue. AT4G21960-YFP gene was then inserted into a pDONR221 plasmid vector in *E. coli*. All steps were confirmed by gels of isolated genomic material. This vector was then transferred into *Agrobacterium tumefaciens* which is a bacterium known to be capable of inserting genes into plant chromosomes. We used transformed bacteria to insert our peroxidase-YFP gene into *Arabidopsis thaliana* and observed for transformed plants. High-resolution microscopy and gel blots were used to

help characterize the expression levels and localization of our YFP-tagged peroxidase protein within transformed plants.

We found visualization of our protein near the cell wall in the roots of transformed plants. Our gel blots however were inconclusive in characterizing the levels of expression of AT4G21960-YFP mRNA. The C-terminal portion of the peroxidase protein was assumed to possess localization sequences, so further studies could be done which inserted YFP into further downstream positions in an attempt to disrupt cellular localization of peroxidase-YFP.

UD-39

USING A REPORTER GENE AND RNA PROBES TO DETERMINE THE RELATIONSHIP BETWEEN AT4G21960 GENE EXPRESSION AND LIGNIFICATION IN *ARABIDOPSIS THALIANA*

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Arabidopsis thaliana is a model organism for genetic study and was used to investigate the expression of a peroxidase gene, AT4G21960, believed to be involved in the production of extracellular lignin. We aimed to investigate where within *A. thaliana* the gene is expressed at both macroscopic and cellular levels. We hypothesize that AT4G21960 will show greater expression in plant structures that have higher concentrations of both vascular and dermal tissue due to cell wall lignification. To this end we created transgenic plants using *Agrobacterium tumefaciens* containing a yellow fluorescent protein construct, of AT4G21960. Macroscopic expression was examined by performing a Northern Blot on flower and leaf tissue samples. The transformation of *A. thaliana* was done with an efficiency of 0.6% and when the zone of maturation is viewed using fluorescent microscopy the transgenic roots appear green when excited using 515 nm light. The Northern blot indicates that AT4G21960 is expressed in both leaves and flowers but that the mRNA concentration within the flowers is an order of magnitude greater. These results show that there is greater expression of the AT4G21960 peroxidase gene in mature root cells which is consistent with our hypothesis that AT4G21960 is involved in the lignification of cell walls. Northern blot analysis showed greater gene expression in the flowers though it is unclear if this is due to lignification. Further experimentation is needed to prove the genes involvement with lignification by examining levels of gene expression and lignin content at various stages of *A. thaliana* structure development.

UD-40

Expression of Gene AT4G21960 in *Arabidopsis thaliana*

Cola Knight-Salicka and Ashley Kelley

BIOL 409: Dr. Kristopher Blee

Secretory Peroxidase family genes of *Arabidopsis thaliana* encode for several different functions. Our goal is to find out where in the plant and what part of the cell the gene AT3G21770 is expressed. According to the online database the gene is highly expressed in the roots. Reporter constructs were designed, isolated and inserted into plasmid vector for transformation of *E. coli* host. Plasmid vector pDONR221 containing kanomycin resistance gene, which was sub cloned into *Agrobacterium tumafaciens*. A similar construct AT4G21960 was used after unsuccessful isolation of AT3G21770. *Agrobacterium tumafaciens* was inoculated into the flowers of the plants; of approximately 5,000 seeds were plated and 19 showed successful growth on the Kanomycin plates. The plants took up the Kanomycin resistant gene and were able to grow. The roots were analyzed under the microscope and several showed fluorescence. This would indicate AT4G21960 gene shows high expression in the roots.

UD-41

Analysis and expression of peroxidase 23, At2G38390, in *Arabidopsis thaliana*

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BIOL 409: Dr. Kristopher Blee

The *Arabidopsis thaliana* Class III peroxidase gene family has 73 members that have diverse function including H₂O₂ detoxification, auxin catabolism, and lignin biosynthesis as a stress response. All 73 of the genes have been analyzed for expression spatially and developmentally and organized into heat maps that can be accessed through bioinformatics sites like genevestigator. The goal of our research is to test the function of the gene, At2G38390, through a plant transformation and to see if its expression in plants matches the literature. Through the use of a Northern blot, and transfecting seeds with the peroxidase gene containing GFP on the C terminus we see where the gene is expressed in the plant. We used recombinant *Agrobacterium tumefaciens* containing the Peroxidase::GFP reporter gene to transform seeds. Total RNA was also isolated from wild type *A. thaliana* and then was probed with primers for the first half of the gene. Transformation efficiency is incredibly low using the *Agrobacterium* host. As such we did not successfully transfect seeds. The northern blot showed no probe activity, but the positive control showed that the procedure did work correctly. Thus, we were unable to accurately test our hypothesis on the localization of our peroxidase gene. Also, our hypothesis on if the peroxidase was expressed in cells, shows little data due to the low transfection rate. Further research would include testing transfection again, and looking at RNA isolated from transfected plants, in order to see where and at what levels the protein was expressed.

UD-42

Decomposition rates in woody plants

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BIOL 350: Dr. Colleen Hatfield

The decomposition of leaves in streams is vital in the nutrient cycling of aquatic ecosystems. Understanding the rates at which these leaves decompose and release their nutrients can further our understanding of stream health and ecology. For this experiment, we compared the rates of leaf decomposition for three different tree species that are common in northern California. These species are American Sycamore (*Platanus occidentalis*), Valley Oak (*Quercus lobata*), and manzanita (*Arctostaphylos* spp.) We hypothesized that the American Sycamore leaves would decompose at the fastest rate. In order to conduct the experiment, we gathered leaves from each of the tree species, measured their mass, and submerged them in the river in mesh bags. We placed four bags of each leaf type in the river and removed one bag per species every week, for four weeks. After drying them in an incubator, we found the new mass after partial decomposition. After collecting the leaves' data, we compared the rates of decomposition between the three species using a scatter plot and a linear regression. Results are still awaiting further data collection. By conducting this experiment, we are further able to understand the significance of each different species' release of nutrients and how it contributes to the overall health of the aquatic community.

UD-43

Cryptozoan Population Variation Near and Far From Butte Creek

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BIOL 350: Dr. Colleen Hatfield

Cryptozoans are ground-dwelling reclusive animals that prefer dark, cool, and moist habitats. Three sites along Butte Creek were selected where two belt transects, 5m by 20m each, one near and one far from the creek were surveyed for cryptozoan habitation. Species diversity, richness, and the theory of island biogeography were assessed by measuring both cryptozoan populations and size of their rock habitats. Expected outcomes for this experiment are that a higher population density, richness, and diversity will be found far away from the creek versus near the creek. The rock habitats are also expected to abide by island biogeography theory, which states that larger habitats will contain a higher level of species diversity. By examining the presence of various cryptozoans near the and far from the creek we can speculate individual species' preferred habitats.

UD-44

Comparing insect activity and size of galls on Valley Oak, *Quercus lobata*, near Big Chico Creek to galls on Valley Oak away from Big Chico Creek

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Bidwell Park is composed of a variety of different plant species, some of which play the roll of host to parasitic insects. The Valley Oak, *Quercus lobata*, is one of the largest oak species in North America and can be found throughout Bidwell Park. Galls can be found on these oaks, which are formed by the larvae of the California Gall Wasp, *Andricus quercuscalifornicus*. The purpose of this study was to show which location of the Valley Oak trees would bear the largest galls with the most abundant insect activity. Fifty galls were collected, ten from five different trees, within each range of distance from Big Chico Creek in Bidwell park. The two ranges used in this study were within 30 yards from the creek and between 30-50 yards from the creek. Insect activity can be determined by examining the different types of holes on that gall. After each gall was measured and evaluated, it was found that, on average, galls farther from the creek were larger in size and also housed the most insect activity.

UD-45

Distribution of poison oak (*Toxicodendron diversilobum*) benefiting from blue oak (*quercus douglasii*) nurse plants.

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BIOL 350: Dr. Colleen Hatfield

Nurse plants aid in the growth and success of plants living within their shade. Blue oak (*Quercus douglasii*) is a California endemic, and is prevalent in the Chico area. Poison Oak (*Toxicodendron diversilobum*) is also native to California and is often found in oak woodlands. Because of the open and dry environment of the area studied, blue oak could potentially serve as a nurse plant for the poison oak primarily because of the shade the oak provides. Blue oak trees were surveyed near the Peregrine Point Trail in Bidwell Park for the presence of poison oak plants. We tested the hypothesis that blue oak served as a nurse plant for poison oak. Because we predicted that blue oak would act as a nurse plant, we also hypothesized that there would be an uneven distribution, with more than

50% of oaks acting as nurse plants. The absence or presence of poison oak beneath blue oak was recorded for fifty-two different trees. Eight oaks were observed to have poison oak growing under them and forty four did not. A chi-squared statistical test indicated that the distribution of poison oak was not equal. Our hypothesis that blue oak served as a nurse plant for poison oak was rejected because more blue oaks did not have poison oak than those that did.

UD-46

Behavioral Patterns of Common Brown Land Snails (*Helix Aspersa*) in Relation to Relative Humidity Levels

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By establishing two separate living environments we examined the effects of relative humidity on behavioral patterns of common brown land snails (*Helix aspersa*). Designed to reveal the relative humidity threshold at which snails will become active the experiment was managed so that relative humidity was the only changing variable. Our experimental hypothesis stated that snails would be more active when relative humidity levels greater than 60%; at levels ranging from 30-60% snails will be moderately active; and at levels less than 30% relative humidity snails will be inactive. We set up two terrariums in which relative humidity was regulated; one treated with paper towels to increase relative humidity (favorable environment) and the other was exposed to an incandescent light bulb without paper towels (unfavorable environments). With seven snails in each tank, the favorable environment exhibited relative humidity levels ranging from 45-75% while the unfavorable environment displayed levels from 20-45%. We labeled snails within each environment to track individual movement independent of group movement. Our observations lasted for 3 continuous days with making observations every 2 hours between 8 a.m. to 5 p.m. We analyzed the results by graphing relative humidity over time and recording each active snail citing. The results found support our hypothesis that snails will be most active at higher relative humidity levels. When levels dropped below 40% snails became completely inactive. Our experiment may give some insight as to why land snails go dormant during the summer months in California's Central Valley.

UD-47

Allelopathic Effects of *S. officinalis*, *M. sachalinensis*, *P. ponderosa* and *Helianthus* on *L. sativa* Seedling Germination

Amanda Perez, Lili Ruiz, and Brian Parker

BIOL 350: Dr. Colleen Hatfield

Allelopathy refers to the chemical inhibition of one plant species by another and can affect plants in different ways. We asked the question, what plants will show allelopathic effects on seedling germination of common lettuce, *Lactuca sativa*. We predicted that some plants may have a greater allelopathic effect upon the seedlings than others, and will show a difference from the control group. We tested sage (*Salvia officinalis*), mint (*Mentha sachalinensis*), pine needles (*Pinus ponderosa*) and sunflower seeds (*Helianthus*). The plant materials of the taxa were crushed individually in a mortar with water, and the water extract poured into petri plates containing 20 lettuce (*L. sativa*) seeds on filter paper. The plates were covered with a lid and set near a classroom window. After one week, measurements were collected for number of seedling germinations and the length of the seedlings. Our resulting treatments had varying intensities of stunting of seedling growth, with *P. ponderosa* completely inhibiting germination. We found that different plants may have different allelopathic effects upon *L. sativa* seedlings, including growth suppression and germination inhibition.

UD-48

Comparing the invertebrate diversity of temporary versus continuous water systems of Lindo Channel and Butte Creek

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BIOL 350: Dr. Donald Miller

Water quality, temperature, stream flow, and other conditions can all contribute to the invertebrate diversity found in a correlating water system. Temporary water systems are known to have less diverse invertebrate ecosystems in compared to permanent less disturbed water systems. Lindo channel is a stagnant water system that serves as a seasonal flood control channel so during times of little rain the channel is not thriving. Butte Creek has a greater stream flow so it is predicted that it will have higher invertebrate diversity. Using Surber samplers invertebrates were collected and the chemical properties: pH, DO₂, Phosphate, and Nitrate levels were determined for water quality purposes. The mean tolerance values, sequential comparison index (SCI), and diversity indexes (DI) for Lindo Channel and Butte Creek determined that Butte Creek had a greater DI at 8.71 while Lindo had a value of 5.8. The chemical properties showed Lindo Channel to be more polluted with higher Nitrate and Phosphate levels, and lower pH and DO₂ levels. Our findings support our hypothesis that Lindo channel has a higher mean tolerance value because invertebrates with higher tolerance values tend to inhabit more polluted water systems.

UD-49

Avian Species Richness in Three Environments: Riparian, Urban, and Agriculture

Lindsey Arnuaud, Blair Geiger, Nate Laux, and Jose Duran

BIOL 350: Dr. Colleen Hatfield

We examined three different sites to compare species richness of bird. The three sites were Big Chico Creek near 5-mile Recreation Area, the city streets just north of Holt Hall on the Chico State Campus, and lastly out at the Chico State Farm. Each site was significantly different from each other. As urbanization encroaches upon agriculture and riparian habitat, we wanted to see if there is a difference in the diversity of birds within each site. We found that the riparian area had the greatest diversity (SI=1.7842, SD=0.2365). Within the riparian area the most commonly seen bird was the Tree Swallow. However, when it came to the number of different species, we found that the agriculture area had the highest at 22. We also found that in the urban area the European Starling was the most abundant. This could be due to the fact that we as humans have created habitat that is well suited for invasive species.

UD-50

Growth of Poison Oak In Upper Bidwell Park

Marrissa Allen, mallen23@mail.csuchico.edu; Marian Furumi, mfurumi@mail.csuchico.edu; Danny Greenwood, dgreenwood@mail.csuchico.edu; Kyle Hill, khill18@mail.csuchico.edu; and Steven Vang, svang610@gmail.com

BIOL 350: Dr. Colleen Hatfield

Plant nursing occurs when the survival of one species relies specifically on the habitat provided by other plant species. Fragile plants survive adolescence by adapting to their environment, which if nursed have greater potential to thrive. This proposed mutualistic relationship is found in a variety of ecosystems subject to dramatic climate conditions. Bidwell Park is an area subject to harsh conditions year round. This study proposes that blue oak, common in the Upper Bidwell area, is a nurse facilitator of another common species, poison oak. Both species were observed in spring, of

which numbers in each species were abundant and fully leaved. They were recorded by relative distance to one another and tabulated into a series of two samples. Each poison oak plant observed was also recorded by size in order to rank strength or age. The results will prove or disprove whether poison oaks are dependent upon blue oak habitat as a component to survival. If significant, this hypothesis will provide greater understanding of nurse plant theory.

UD-51

Spatial Ant Niche Partitioning

Nikki Ramey, Tera Sakulsinghdusit, Evan Anderson, and Ana Barragan Trejo
BIOL 350: Dr. Colleen Hatfield

The main objectives for our experiment in ant niche partitioning are: to evaluate the way in which different species interact, reason why some species are rare and others are plentiful and determine the structure of the community consisting of multiple ant species. In doing this we evaluate principles of competition, resource partitioning, exclusion, coexistence, and fundamental and realized niche. The methodology used in conducting an ant niche partitioning experiment was to first establish separately among the two ant species the preferred food resource. Four petri dishes were placed at two sites of red and black ant species, each containing 5 grams of banana, tuna fish, orange and pretzel. These sites were monitored separately for food preference using the amount of ants on source over time as a measure. The preferred food was concluded to be tuna fish among both red and black ants. Using our findings for food preference we then examined ant niche partitioning. Five grams of tuna was placed in 6 petri dishes and distributed at approximately 3-meter intervals between the two ant species. Petri dishes #1 and #2 were placed closest to the red ants, #5 and #6 placed closest to the black ants, while petri dishes #3 and #4 were placed in the middle between the two ant species. Ants were evaluated after one hour on three different days, examining the number and kind of ants on each petri dish. Results of this experiment showed that red ants dominated the niche and therefore there is ant partitioning of resources on a spatial scale.

UD-52

Genetic Investigation of Prodigiosin Production in *Serratia marcescens*

Authors: Bacterial Physiology Class
BIOL 412: Dr. Andrea White

In order to better understand the mechanism of the red pigment, prodigiosin, production in *Serratia marcescens*, a transposon induced mutant library was created, in which mutants with altered pigment production were isolated. As a class, 17 pigment mutants were isolated, ranging in phenotypes from hyper-pigmentation to no pigmentation. The variation in phenotypes observed indicates the Tn (transposon) was inserted into different regions in the chromosome of *S. marcescens*. From these mutants, 14 clones of the Tn insertion sites from the original mutants were created. Of these clones, 11 were believed to have different Tn insertion sites based on the differences in the fragment sizes of the cloned DNA, as seen by gel electrophoresis. One Tn insertion site was successfully sequenced and shows that the Tn insertion is in the *pigE* gene, which is a known part of the biosynthetic operon of prodigiosin in *S. marcescens*. To determine if the mutation in the pigment mutants has an effect on growth rather than just pigment production, the growth of each mutant was compared to the wild type under a variety of growth conditions. It was found that the majority of mutants grew as well as the wild type on most media. However, there were also several that displayed growth defects compared to the wild type, showing that the mutated genes affected more than simply pigmentation in these mutants.

UD-53

THE MEASUREMENT AND ANALYSIS OF HABITAT USAGE BY BIRD SPECIES IN A GRASSLAND COMMUNITY

BENSON LAURIE, LA KHANG, and ABBY RIZZO

BIOL 434: Jay Bogiatto

We studied diversity for bird species related to selective versus random habitat use of plant species and foliage heights. Our study took place in the Vina Plains Preserve grasslands of the Northern Sacramento Valley from April 2011- May 2011. We conducted one vegetation survey and six bird censuses.

We used a 20,000 square meter area, and established parallel straight line transects every 20 meters. We took 100 vegetation measurement points within the plot. This recorded measurement consisted of presence/absence of foliage height, and plant species data. We then conducted bird census data. During each of six diurnal surveys, we most frequently observed horned larks (*Eremophila alpestris*), savannah sparrows (*Passerculus sandwichensis*), and western meadowlarks (*Sturnella neglecta*).

Our data showed the horned larks used habitat selectively, while the savannah sparrows and western meadowlarks used habitat in a random fashion. The consistent regularity of avian use of this grassland community suggests the importance of grasses/forbs for nesting and foraging for these three passerine species. Protection of this grassland community may be critical for the winter use and nesting of these Central Valley species.

UD-54

Avian Use of Vegetation in Sacramento River Riparian Habitat

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BIOL 434: Jay Bogiatto

The goal of this class project was to determine the diversity for bird species, plant species, and foliage heights in a variety of habitats, and to determine whether the birds are using the plant species and foliage heights selectively or randomly. Our group's study area was located within Sacramento River Riparian habitat, located within the Pine Creek Unit of the Sacramento River National Wildlife Refuge. We conducted six spring bird surveys (at dawn on different days) along with vegetation composition surveys. We compared our data with other groups in our class who studied Blue Oak Woodland, Ecotone (between Oak Woodland and Coniferous Forest), and Grassland habitats near Chico, California. Using the Shannon Diversity Index, our class found that the habitat with the highest diversity for bird species, plant species, and foliage height was the Ecotone habitat. The next highest diversities were found in the Sacramento River Riparian habitat. We also determined that the birds in the Sacramento River Riparian habitat were using the plant species selectively.

UD-55

The Relationship Between Avian and Vegetative Diversities in an Ecotonal Habitat

Ninette Daniele, Shannon Rich, and Lindsay Sedar

BIOL 434: Jay Bogiatto

Avian ecology in mixed oak woodland/coniferous forest bordering chaparral habitat demonstrated greater diversities than communities found in other study sites comprised of riparian,

grassland or oak woodland. A small number of bird species dominated the habitat, although a considerable number of species were identified. This study investigated height and species of vegetation utilized by birds in relation to diversities. We conducted several bird censuses within our ecotone study site and recorded vegetation species and height in which birds were found perching, preening and foraging. Foliage species and height diversities in this ecotone environment were demonstrated to be more varied than those of the other study sites. These results may indicate that higher vegetative diversity provides suitable resources to a broad variety of avian species. Perhaps edge effect in ecotone communities produces a greater density of organisms of one species and greater overall number of species than found in bordering communities.

UD-56

Avian Survey of Habitat Usage in Foothill Woodland (blue oak zone)

William McCall, Glenn Woodruff & Matt Lane

BIOL 434: Jay Bogiatto

Studying habitat usage by organisms is important for conservation management in a time when fragmentation and destruction is increasing. We conducted an avian habitat survey to determine variation of habitat usage by different species within specific habitat type. One of the goals of the Ornithology 2011 class was to survey several habitat types to contribute to an ongoing data set of avian diversity, plant diversity and habitat usage. Our study site was located in Upper Bidwell Park; a blue oak woodland. Our survey area was a one-hectare plot consisting of one hundred survey points. Each survey point represented a location in which we would search for birds using the habitat within a finite proximity. In this way we determined what vegetation type each individual used within our survey plot.

The bird's reason for using each vegetation type was not recorded, but could include shelter, nutrient gleanings, and mate attracting. Within our survey plot, we found a general trend suggesting that the majority of birds prefer using blue oaks most of the time. Within the blue oak woodland, blue oaks can potentially serve as oases in steep contrast to the surrounding grasses and forbs. Grasses and forbs provide birds with grain for food, but are limited in providing shelter. Blue oaks can provide shelter away from predators, elevated vantage points, and food and nesting habitat for certain species. Gathering this data is important in evaluating the interactions between flora and fauna. Knowing how birds utilize their environment is key for management decisions.

UD-57

Abiotic Factors & Activity Patterns of Land Snails

Becky Suenram, Michelle Pritchard, and Mai Jao

BIOL 350: Dr. Colleen Hatfield

The objective was to analyze the various relative humidity levels and the effects that it had on the snail activity, along with exploring the relationship those findings have in comparison to the snails natural habitats characteristics. The study was conducted in a controlled environment in a lab where the room temperature was consistent, the snails were housed in two identical glass tanks and were placed in an area that there would have no disturbance done to it to alter the data being collected. Ten snails were collected from one site from a garden in Chico, they were then divided into two groups and housed in separate tanks. In each tank wet paper towels were placed on the bottom of the tank, the five snails were placed in the tanks and then the same variety of lettuce was distributed to each tank in the same amount of one leaf broken up and scattered along the bottom to allow for more accessibility to the snails. One tank represented the more humid climate for the

snails that more closely represented the Chico climate during the snails more active time of year and the other tank was less humid to more closely represent the Chico climate during the snails less active time of year, so it was placed under an incandescent light bulb. After setting up the experiment, data was then collected each day of the experiment, gathering the relative humidity, by using a humidity detector of each tank and the temperature of each tank. On a daily basis, the paper towels at the "wet" tank (more humid) were sprayed down with a water bottle to ensure consistent humidity levels. The "dry" tank (less humid) only received the wetting of the paper towels on the first day and were left alone to allow resemblance of the drying of the soils in Chico in the summer from the sun light. Each day both tanks were given new food at the same amounts, leaving old food in the tank as well and pictures were taken each time data was collected to better monitor the snails activity throughout the experiment. The data at the end of the experiment proved that the snail activity was greater in the more humid environment over the snail activity in the less humid environment.

Undergraduate Research

UIR-58

Ecological Succession After Wildfire Affects Rate of Insect Colonization of Newly Available Host Plants.

Rebecca M. Holden, rebeccaholden747@yahoo.com

BIOL 489: Drs. Donald Miller, Colleen Hatfield

In plant communities, disturbances such as wildfires prime the land for ecological succession, providing new resources that herbivorous insects can exploit. For example, in the California chaparral, wildfires kill manzanita shrubs, but can also stimulate germination of new plants.

At the Big Chico Creek Ecological Reserve (BCCER), Butte County, California, a cohort of juvenile plants of two species of manzanita, *Arctostaphylos manzanita* (common manzanita) and *Arctostaphylos viscida* (whiteleaf manzanita), was germinated by fire in 1999. These juvenile plants ("sinks") may be colonized readily by *Tamalia coweni*, a gall-inducting aphid, persisting on surviving ("source") plants in close proximity. The proportion of colonized to uncolonized juvenile shrubs may be directly related to their distance from mature source plants. To test this prediction, we are studying populations of *A. viscida* and *A. manzanita* at the BCCER. The position of each plant has been recorded to 0.5m precision with GPS (Global Position System technology), and the presence of galls provides direct evidence of colonization by aphids. Preliminary data indicate a positive correlation between source-sink proximity and colonization rates of juvenile plants. These results can be implemented to describe ways in which secondary succession mediates dispersal and colonization by aphids, and by extension, herbivorous insects generally.

UIR-59

Evaluating efforts to improve water quality in an urban city in China

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BIOL 399: Dr. Colleen Hatfield

Like many cities in China, with the rapidly increasing economy and a large population, Suzhou City, located in Jiangsu Province in southeast China, faces serious issues related to water pollution. The city is adjacent to Shengze Lake, which drains into Yangcheng Lake. A water quality improvement project for Shengze Lake, was finished by Suzhou Environmental Protection Bureau in 2009. The

project included: building an- eight hundred acre Eco park, controlling the rate of flow of each river which connected with Shengze Lake, damming all the sanitary wastewater and industrial effluents and clamping down on cultivation in the lake. The question address here is whether the project was successful in improving water quality not only in Shengze Lake but also Yangcheng Lake. For both lakes, water quality data included pH, temperature, dissolved oxygen, Permanganate, COD, ammonia nitrogen, total Nitrogen, and total Phosphorus. The data was collected in April and October in 2003, prior to the improvement project, and again in 2010. The evidence suggests that the main aspects that determine water quality are decreasing and the water quality for Yangcheng Lake is change from fourth level which is water used by industry to third level which is second level of Protected areas for surface water source. For example, ammonia nitrogen, total nitrogen and phosphorus show improvement for both lakes. Dissolved oxygen is increasing and the pH is more alkaline in both lakes.

UIR-60

Monitoring for presence of an amphibian pathogen by quantitative polymerase chain reaction

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BIOL 399: Drs. David Keller and Tag Engstrom

The emerging disease called Chytridiomycosis has been implicated in the decline of amphibian populations around the world, including in California. The disease is caused by water-borne spores of Chytrid fungus *Batrachochytrium dendrobatidis* (Bd). Frogs and newts from Big Chico Creek Ecological Reserve (BCCER) were captured from the “Horse Trough” area and rubbed with sterile swabs, then released. We collected 21 samples from *Taricha sierra*, 2 from *Taricha granulosa*, and 8 from *Rana boylei* (yellow-legged frog). DNA was successfully extracted from all field samples, as analyzed by absorbance-spectrometry. Quantitative real-time polymerase chain reaction (qPCR) was used to amplify *Taricha tarosa* cytochrome B, from our newt field samples. PCR was also used to amplify 5.8S ribosomal RNA from Chytrid (*Batrachochytrium dendrobatidis*) from isolated Bd DNA. Though we were able to successfully amplify the *Taricha* DNA from our samples, we detected no sign of Chytrid. This implies that the fungus has not made it into the BCCER, though further testing and sampling should be done to verify these results.

UIR-61

Utilization of 3' RACE in generating primary transcript of miR-375

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BIOL 399: Dr. David Keller

Recent advances in molecular biology have allowed the identification of novel genes based on “anchor” priming approach in PCR. One of the challenges in molecular biology is to map genes that are in low abundance. It is becoming increasingly apparent that these low abundance genes play major roles in genetic diseases. In order to combat genetic diseases, we must be able to compose a genomic layout, defining where each gene starts and ends. The advent of 5' and 3' RACE (rapid amplification of cDNA ends) has provided a tool to clone low abundance RNAs, and obtain sequence data. 3' RACE utilizes the polyadenine tail that is commonly seen on RNA molecules to create a cDNA library. With this anchor, two gene-specific primers are used in separate rounds of PCR in order to specifically amplify the start and the stop of the gene. We are particularly interested in a pancreatic gene called miR-375 (micro RNA 375), which regulates insulin secretion and is overexpressed in type 2 diabetes. This gene has been linked to development of the pancreas, especially beta cells (insulin secreting cells). MicroRNA-375 is a small, 21 nucleotide RNA molecule, but is processed from a larger

RNA with an unknown beginning and end. By mapping out mir-375, problems associated with hyperglycemia could be remedied in the future.

Graduate Class Projects

GC-62

Chromatin immunoprecipitation and real-time polymerase chain reaction (qPCR) as a method to measure gene expression

Juan C. Araujo, Alena Chin-Curtis, Elizabeth A Clark, Sarah C. Hoddick, Broderick Illa, Lisa R. McKowan, Freshta Obaidi, Raj S. Patel, Daniel Poggetti, William H. H. Reeder, Lindsey Wallace
BIOL 609: Dr. David Keller

Disease conditions can be caused by a modification of gene expression. The chromatin immunoprecipitation (ChIP) assay together with real time PCR (qPCR) can be used to measure the association of transcription factors with regions of the genome. This information is relevant for discerning mechanisms of differential gene expression. Thus ChIP and qPCR can be used to determine disease mechanisms. For example, RNA polymerase II (RNAPII) may change its activity in response to cellular signals. As the main polymerase for protein coding genes, dysregulation of RNAPII activity could lead to disease states.

ChIP is a method which analyzes whether a particular transcription factor is bound to a specific DNA region. DNA sequences were analyzed by real time PCR (qPCR) using gene specific primers. Three primer sets were designed against three different regions of the gene “microRNA-375” and were found to successfully amplify their target regions. An RNAPII antibody was tested and found to bind specifically compared to a control immunoglobulin (IgG) antibody. Our results indicate that RNAPII binds differentially to different regions within the same gene.

GC-63

PUTATIVE ANION EXCHANGE PROTEIN USED FOR THE ACQUISITION OF BICARBONATE IN THE MARINE HAPTOPHYTE *EMILIANIA HUXLEYI*

Lindsey K. Wallace
BIOL 610: Dr. David Keller

The dominant form of dissolved inorganic carbon in seawater is bicarbonate, which requires an acquisition mechanism to convert bicarbonate into CO₂ for RuBisCo. Bicarbonate has been shown to be limiting to both photosynthesis and calcification in *Emiliana huxleyi*. Herfort (2002) has suggested through inhibitor experiments that *E. huxleyi* acquires bicarbonate by an anion exchange protein (AE1) and an external carbonic anhydrase (CA). CA is active when bicarbonate is below 1mM, while AE1 remains functional during low and high concentrations of bicarbonate. Historically, coccolithophores emerged during the Tertiary when concentrations of bicarbonate were much higher than today, suggesting that AE1 was derived as the primary mechanism while CA is supplementary. AE1 is well studied in mammalian systems for its exportation of bicarbonate out of cells, and AE1s have also been identified in other algae species (Herfort 2002). Since Herfort's publication the *E. huxleyi* genome has been sequenced allowing us to actively search for AE1 homologous genes. Using JGI *E. Huxleyi* (strain CCMP1516) genome, NCBI BLAST for identification of homologs to AE1, MEGA5 for phylogeny construction, and SWISS Prot to analyze protein sequences I have identified a gene sequence matching the AE1 C-terminal domain. In mammals the C-terminal domain of AE1 is 70% conserved but because the *E. huxleyi* genome hasn't been fully constructed,

and remains in scaffolds and fragments it is impossible to determine further the structure of this putative AE1 protein at this time.

GC-64

Phylogenetic Analysis of Thermoacidophilic Amoeboflagellate *Tetramitus thermacidophilus* based on 18s SSU rRNA Sequences

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BIOL 610: Dr. David Keller

Extreme environments are known to select for organisms able to withstand the environmental stresses of pH, temperature, and chemical composition. Organisms able to adapt are primarily microbial. *Tetramitus thermacidophilus* is known to be an acidophilic, thermotolerant heterolobose amoeboflagellate, and has been genetically identified in natural geothermal acidic sites, as well as the infamous acid mine drainage (AMD) site, Iron Mountain Mine. A related organism was isolated from Boiling Springs Lake in Lassen Volcanic National Park, and is considered the major predator of other microbes in the environment. Here we identify the genetic divergence of similar organisms found in similar environments across the globe via 18s SSU sequence and ITS sequences and determined the isolate from BSL to be novel based on 18s SSU sequence.

GC-65

Phylogenetic analysis of *Arabidopsis thaliana* class III peroxidase promoters and regulation of expression

Freshta Obaidi

BIOL 610: Dr. David Keller

Class III peroxidases are found in all land plants and they serve many functions such as lignification, stress tolerance, and pathogen defense. Multiple isoenzymes are found in many species such as *Arabidopsis thaliana* and *Oryza sativa*. It is believed that the 73 peroxidases in *Arabidopsis* are a result of extensive gene duplications. The large number of peroxidases, the many substrates peroxidases can utilize, and their expression in different plant tissues suggests that each peroxidase plays a specific role within the plant. Of the 73 peroxidases in *Arabidopsis*, many remain without an experimentally defined function. In this study, bioinformatics was used to determine if similarity in the promoter sequences of 18 class III peroxidases in *Arabidopsis* showed any correlation to regulation of the peroxidases. Peroxidases with similar regulation patterns may have like functions. A phylogenetic tree based on 500 bp upstream of the start codon of each peroxidase was constructed. Under some conditions, such as treatment with abscisic acid, more similar promoters showed similar regulation. Under conditions such as wounding, there was no similarity in regulation. Studying the regulation of peroxidases from a phylogenetic approach will allow for a better understanding of peroxidase function, regulation, and evolution, which are significant because of the agricultural and commercial importance of class III peroxidases.

GC-66

Using Bioinformatics to compare enzymatic genes from low and neutral pH

Areeje Almasary

BIOL 610: Dr. David Keller

Fungal enzymes are used in a variety of industrial and biotechnological applications in which acid stable enzymes are more functional (Kimura et al. 2000). Understanding genes encoding enzymes that are functional in low pH can help in enzymatic studies for industrial and biotechnological

applications. Here, I aligned sequences of genes that encode xylanases from different fungal species; some of these enzymes optimally function at low pH (pH2) and others in neutral pH. It was observed that sequences for acidophilic enzymes contain a sequence for a disulfur bond which helps in stabilizing the enzyme in low pH (Michaux et al. 2010). These findings are consistent with what Michaux, C. et al (2010) have found and might help in enzymatic studies.

GC-67

Bioinformatics analysis of the possible Evolutions of different proteins associated with PULCA production in *Emiliana huxleyi*

Sarah Hoddick
BIOL 610: Dr. David Keller

Emiliana huxleyi is a marine alga that produces novel lipids in the form polyunsaturated long chain alkenones, alkenes, and alkenoates (PULCA) with lengths of 37-39 carbons and trans bonds every 7 carbons. These lipids are of particular interest for possible use as a biofuel. In order to fully realize the potential of *E. huxleyi* there needs to be a better understanding of the biosynthetic pathway. To do this it is important to understand what proteins are utilized and if they are expressed in any other organisms that also produce lipids in a similar manner. Work has already been completed on what proteins are utilized so in this study the focus remains to obtain information on how similar this process could be to other organisms. To do this *E. huxleyi* sequences were run through BLASTn searches to find homologs in other organisms. The sequences were aligned and phylogenies created for three different proteins of interest: Manonlyl CoA, phosphatidylcholine-sterol O-acyltransferase, and Pyruvate dyhydrogenase. This helped to show how these proteins may have arisen in other organisms and that these organisms may have similar lipid producing mechanisms. Further research would help illuminate some of the controls and constraints of lipid synthesis in *E. huxleyi* and other similar organisms.

Graduate Research (Thesis)

T-68

Assessing Ecological Recovery in Montane Sierra Nevada Montane Meadows

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Montane meadows in the Sierra Nevada are biodiversity hot spots for plant communities and as such can provide a variety of resources including wildlife habitat. The meadows also play an important role in filtering snowmelt to provide an important source of water for both wildlife and Californians. Combinations of meadow importance and degradation through human disturbances have led park managers and scientists to implement restoration efforts to improve hydrologic connections and biotic health within these meadows.

My thesis focuses on evaluating the ecological status of undisturbed, disturbed and restored high elevation montane meadows in the Sierra Nevada. Undisturbed meadows located in Yosemite National Park will provide a frame of reference for assessing the ecological integrity of the restored and disturbed meadows in Big Trees State Park watershed. I am documenting hydrologic connectivity and plant community composition, emphasizing species diversity and invasive species extent, across this disturbance gradient. Understanding how the meadow plant community correlates with

hydrologic changes and site status in Sierra Nevada montane meadows is important for current and future management decisions for restoration and conservation initiatives.

T-69

The influence of flowering time on pollinator-mediated interactions between *Clarkia unguiculata* (Onagraceae) and its neighbors

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Competition and facilitation between plants can be mediated by pollinators, and these interactions can shape selection for reproductive traits such as flowering time. *Clarkia* (Onagraceae) congeners may facilitate their pollination through synergistic attraction and maintenance of their specialist pollinators. Earlier flowering species may attract and support populations of these specialist pollinators, ameliorating the pollination environment of later flowering *Clarkia* plants. Because the late-flowering *C. unguiculata* enjoys efficient pollination by specialist bees, we hypothesize that competition with plants visited primarily by generalist pollinators exerts little selection on its flowering time. We will employ a factorial experiment in which early- and late-flowering *C. unguiculata* plants are grown in one of three conditions: (a) alone, (b) with the generalist bee-pollinated *Monardella lanceolata* (Lamiaceae), or (c) with *Clarkia purpurea* ssp. *purpurea*. To evaluate indirect interactions for access to pollinators, we will compare seed production in open-pollinated *C. unguiculata* plants with pollen-supplemented plants (i.e., whole-plant pollen limitation for seed set). Decreased pollen limitation in arrays containing the congener *C. p. ssp. purpurea* would suggest that shared pollinators facilitate increased seed set in these species. Greater pollen limitation in early-flowering *C. unguiculata* arrays regardless of the presence of *M. lanceolata*, a potential competitor for generalist pollinators, would support the hypothesis that interspecific competition for generalist pollinators exerts weak selection on flowering time in species that employ specialist pollinators. This study will broaden understanding of how biotic interactions select for reproductive traits.

T-70

Characterizing migration patterns, winter habitat and diet of Northern Saw-Whet Owl (*Aegolius acadicus*) in the Sierra Nevada Foothills of California

Julie Shaw, R. J. Bogiatto, Tag Engstrom, and Colleen Hatfield

Northern Saw-Whet Owls (NSWO, *Aegolius acadicus*) are a small yet highly migratory raptor widely distributed across much of North America, yet their ecology locally is poorly understood. This study aims to characterize the fall migration ecology of overwintering or stopover NSWO by radio-tracking individuals at Big Chico Creek Ecological Reserve (BCCER). A total of 9 NSWO were tracked during the fall/winter migration season in 2010-2011. Habitat was recorded at each roost and pellets collected for diet analysis. Of the 9 tracked NSWO, 3 moved off the BCCER after a few days and were not redetected; two moved off the BCCER into adjacent foothill areas; and four spent at least 2 weeks on BCCER with a maximum of 93 days. Results showed preference for canyon live oak (*Quercus crysolepis*) and toyon brush (*Heteromeles arbutifolia*), with 52 of 80 diurnal roosts in *Q. crysolepis* and 12 in toyon. Because of the strong preference (65%) for evergreen oak species, average roost height of NSWO was 9.33 meters (+/- 7.26 SD). Roost species and height also correlated with individual NSWO preference; few individuals were strictly in toyon or California bay (*Umbellularia californica*), while others preferred *Quercus* species. Finally, 46 NSWO pellets were collected underneath known roost sites. Prey analysis is underway, and identified species include *Microtus* and *Peromyscus* species.

T-71

EVALUATING INTRODUCTION APPROACHES FOR *NEOSTAPFIA COLUSANA* AND *TUCTORIA GREENEI* AT THE SACRAMENTO NATIONAL WILDLIFE REFUGE COMPLEX.

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Vernal pool habitats and associated plant and animal taxa have been significantly reduced by conversion to agriculture and urbanization. As a result, a number of vernal pool dependent species have become rare; this is true for several grasses, including *Neostapfia colusana* (Colusa grass) and *Tuctoria greenei* (Greene's tuctoria).

The goal of this research is to examine the potential for introductions of rare grasses into vernal pools. During spring and summer 2010, we gathered physical and biological data on the study/restored and reference sites to inform the species introductions. We measured dry down to compare hydrology, mapped the locations of Colusa grass and Greene's tuctoria in the reference pools, conducted surveys of the vegetation communities in each of the pools, and observed general phenological trends.

We used this knowledge of the two species and habitats, along with pool topography, to inform our introductions so that we can identify the most suitable habitats for the species introductions. We conducted the two grass species introductions in winter 2011. In April 2011, initial results from the introductions show germination of Greene's tuctoria in the restored pools. We will continue to monitor results of the introductions through spring and summer 2011. 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.

T-72

Food Availability for the Yellow-billed Cuckoo along the Sacramento River

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Though the Yellow-billed Cuckoo has a broad geographic distribution in the U.S. it has a limited distribution in the western U.S. and is an endangered species in California. The Sacramento River in central California historically supported the highest populations of Yellow-billed Cuckoos in the state. Though previous studies have shown cuckoos are found in restored habitat, population numbers have not increased in spite of concerted efforts to restore cuckoo habitat, especially along the Sacramento River. There is a pressing need to better understand why population numbers are not rebounding. One possible explanation is that available food is not sufficiently abundant or of the right composition to support more birds. The proposed study will investigate the food availability and composition for cuckoos along the Sacramento River. I will sample for arboreal insects in the restored habitats as well as remnant forest sites with and without cuckoos in order to determine whether prey availability varies by habitat type and bird presence. This is the first study of food availability for Yellow-billed Cuckoos in the U.S, and it could give us insight into why this species continues to decline along the Sacramento River.

T-73

Reproductive Isolation in *Mimulus*

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Reproductive isolation between recently diverged species is often accomplished by a suite of ecological and physiological factors. As a component of an ongoing study, we report on three potential prezygotic barriers to hybridization between the closely related *Mimulus glaucescens* and *M. guttatus*: geodaphic affinity (“ecological” isolation), floral morphological differences (“mechanical” isolation), and differences in pollen tube growth rate (“gametic” isolation). A Northern California range map based on collection records was constructed with Geographic Information Systems (GIS), and this was used to compare their geodaphic distributions. *Mimulus glaucescens* occurs more frequently on the Jepson subecoregion of the Cascade Range foothills, whereas *M. guttatus* ranges more broadly, and is not restricted to the Sierra-Cascade interface. Floral traits relevant to pollen transfer were compared between taxa, and significant differences were found in floral morphology. Finally, we compared pollen tube growth rate *in vivo* using hybrid and conspecific hand-pollinations among multiple allopatric populations, and found no significant differences among crosses. Based on results from these three factors, ecological isolation, as conferred by geological affinity, and floral morphology may be important for limiting hybridization between these species. These results mirror other recent studies exploring boundaries between closely related plants, in which species distributions have been found to confer substantial reproductive isolation.

T-74

Western Pond turtle population characteristics at four sites in Northern California

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In the 2010 season, we sampled four sites in Northern California for Western Pond turtles (*Emys marmorata*) collected measurements on each turtle that were used to calculate body condition scores, sex ratios, and growth histories at each site. We found that turtles from lowland, modified habitats grew faster, grew larger, showed male biased sex ratios, and showed sexual dimorphisms as compared to turtles from the Big Chico Creek Ecological Preserve. These results will help to understand demographic processes that affect turtle populations and allow us to interpret current and future physiological data taken on these animals.

T-75

miR-191 and miR-425: Possible regulators of pancreatic beta cell function

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MicroRNAs (miRNA) have been recently recognized as key regulators of the translation of messenger RNA (mRNA). miRNAs are involved in virtually all cellular processes, have the ability to target multiple genes, and play important roles in diseases such as cancer and diabetes. Our lab has identified two miRNAs that could potentially be involved in the cellular processes of pancreatic beta cells, miR-191 and miR-425. We first became interested in miR-191 and miR-425 because they may be regulated by two important transcription factors, pancreatic and duodenal homeobox 1 (PDX-1) and neurogenic differentiation 1 (NeuroD1), both of which are vital for the development of pancreatic beta cells and for the regulation of insulin release. We have also observed that miR-191

and miR-425 may be up-regulated when cells are treated with glucose. This preliminary data makes miR-191 and miR-425 of particular interest, since regulators of insulin release are usually regulated by the presence of glucose. Bioinformatic analysis suggest possible roles for miR-191 in regulating apoptosis-inducing genes; as well as possible regulation of exocytosis by miR-425.

T-76

Regulation of microRNA-375

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Many of the molecular details in type 2 diabetes are not yet understood. It is known that microRNA-375 regulates insulin secretion in pancreatic beta cells and human subjects with type 2 diabetes have abnormally high levels of this microRNA. Insulin secretion is activated by the pharmaceutical exendin-4 through its cell-surface receptor GLP-1 and the small intracellular signaling molecule cyclic-AMP. Based on previous evidence, cyclic-AMP downregulates microRNA-375 and thus represents a potential mechanism for how exendin-4 therapy works. Glucose also downregulates microRNA-375. The molecular details of these mechanisms are not yet understood. I am using molecular cloning, real-time PCR, chromatin immunoprecipitation, luciferase reporter, and bioinformatics to unravel the molecular mechanism by which cyclic-AMP and glucose downregulate microRNA-375. My hypothesis is that cyclic-AMP and glucose increase insulin secretion by down regulating microRNA-375 through a protein kinase A pathway. The results of this study could bring attention to microRNA-375 as a potential target for microRNA silencing therapy in the treatment of type 2 diabetes.

Notes