

**TWELFTH ANNUAL  
STUDENT RESEARCH  
POSTER SYMPOSIUM**

**MAY 16, 2008  
1-4 PM**

**HOLT HALL**

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

# POSTERS

LOWER DIVISION CLASSES, UPPER DIVISION CLASSES AND  
UNDERGRADUATE RESEARCH

Holt 225

GRADUATE CLASSES, THESIS RESEARCH

Holt 227

ENTOMOLOGY CLASS DISPLAY

Holt 235

May 15-16  
Greenhouses Open to View  
10am – 3pm

*California State University, Chico*  
*Department of Biological Sciences*

**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*

*2002 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*

**Recipients of the**  
**Michael Abruzzo Outstanding Scientist Award**

*2006 Collin Biondo, Andrew Anderson, Chelsea Riggs, Nicole Tunnell*

*2007 Charissa Becker-Martinez, Freshta Obaidi*

# Lower Division Class Projects

## **The Impact of Vibration on invertebrate diversity**

BIOL 152 - Stephanie Alward, Tim Hanson, Ryan McEnery, Jesse Patrick  
Dr. Christopher Ivey, Darhl Whitlock

Hypothesis: the area near the tracks would have less insects because the train's vibration and noise would cause disruption. While the area away from the tracks would have more insects due to less disruption. The null hypothesis was that both places would have the same amount of insects. By way of capturing insects with pit traps in a low disruption area near a creek and a high disruption area near train tracks by a creek. The diversity was calculated using the Simpson and Shannon indexes. Based on the results of the t-test we could not accept the hypothesis.

## **Effects of varying water treatments on germination rates of *Raphanus setivus*.**

BIOL 152 - Jeremy Ault ([ault\\_jeremy@yahoo.com](mailto:ault_jeremy@yahoo.com)), Nicole Downes ([ndownes08@gmail.com](mailto:ndownes08@gmail.com)),  
Jaime Mills ([jaimie.mills08@yahoo.com](mailto:jaimie.mills08@yahoo.com))  
Sponsor: Dr. Christopher Ivey

Cherry belle radishes (*Raphanus setivus*) absorb water through osmosis, the diffusion of water through a semi-permeable membrane from a lower concentration of solute to a higher concentration. A seeds ability to germinate is dependent on its ability to undergo osmosis to absorb nutrients needed for growth. The type of water the seed is treated with could affect the rate of germination of the plant. Does the treatment of tap, distilled, sugar, or salt water affect the germination rates of cherry belle radish seeds? It's hypothesized that the radishes treated with tap and distilled water will have the highest rates of germination, while salt and sugar water seeds will have the lowest germination rates. Plastic trays were prepared with the same types of soil and radish seeds in the 32 compartments. The seeds were watered with one of the four different water treatments, set in the sun and observed until germination. Seeds treated with tap water had the highest average frequency of 0.2875, seeds treated with distilled water averaged a frequency of 0.2125, seeds planted in salt or sugar water did not germinate. The hypothesis that the sugar and salt water treated seeds wouldn't germinate while the tap and distilled water treated seeds would germinate can be accepted with a P-value of 0.000996 from a t-crit of 2.946685. The radishes germination rate appears to be affected by presence of solute in the water. Further experiments involving other types of solutes could be conducted to determine the affects of other solutes.

## **Study of Community Diversity Using Four Different Scented Pit Traps**

BIOL 152 - Kimberly Bacigalupo ([klbacigalupo@gmail.com](mailto:klbacigalupo@gmail.com)), Yer Lee  
([ylee25@mail.csuchico.edu](mailto:ylee25@mail.csuchico.edu)), and Paterra Yang ([pyang17@mail.csuchico.edu](mailto:pyang17@mail.csuchico.edu))  
Professors: Christopher Ivey and Darhl Whitlock

Species diversity is a measure of both species richness and species evenness. In invertebrates,

scent and odour are essential for survival. Because of their reliance on scent for survival, the species diversity of invertebrates in different communities of a certain ecosystem may be affected. This experiment focused on analysis of a shady ecosystem with moderate plant growth to determine if there is species diversity among invertebrates when exposed to scents (cinnamon, almond, and vanilla). Five pitfall traps of each scent, along with a control, were filled with unscented soap and left outside for five days to allow capture of invertebrates. The data gathered from these cups were then used to perform an ANOVA analysis to determine diversity. The p-value from the one way ANOVA on the Shannon index was 0.0015 and 0.0050 for the Simpson index, both of which were less than the alpha value of 0.05, indicating that there is significant difference between the community diversities of the different scented pitfall traps.

### **A comparison of species diversity and richness in Lake Oroville Ca, in respect to the Feather River immediately below the dam.**

BIOL 152 - Matt Baker [wvxcrunner@hotmail.com](mailto:wvxcrunner@hotmail.com), Mitchell Haaser [Notlite@aim.com](mailto:Notlite@aim.com), Sean Moran Nachosito2002@yahoo.com  
Professor Dr. Chris Ivey [ctivey@csuchico.edu](mailto:ctivey@csuchico.edu)

To test if there is any difference in invertebrate species richness and diversity in Lake Oroville compared to the Feather River below the Oroville dam, 10 pit falls were placed at each location and filled  $\frac{3}{4}$  full of a 10% detergent solution. While the species richness of each location was the same with 7 species, the Shannon index shows that the river had an index of 1.483 while the lake had an index of .9823. Our conclusion is that the diversity along the Feather River was greater than the diversity in Lake Oroville even though the richness of each location was the same.

### **Mealworms In A Warm or Cold Climate**

BIOL 152 - Zachary Baroni ([zbaroni@csuchico.edu](mailto:zbaroni@csuchico.edu)), Scott Young ([syoung18@csuchico.edu](mailto:syoung18@csuchico.edu)), Paul Navarez ([pnev24@yahoo.com](mailto:pnev24@yahoo.com)), Ryan Rothenwander ([rrothenwander@csuchico.edu](mailto:rrothenwander@csuchico.edu))  
Faculty: Darhl Whitlock, [dwhitlock@csuchico.edu](mailto:dwhitlock@csuchico.edu)

The significance of our project is to determine if mealworms eat threw apples at a faster rate in a warm climate or a cold climate.

Hypotheses: H<sub>1</sub>: Mealworms will eat threw the apples at a fast rate in a warmer climate. H<sub>0</sub>: Mealworms will not eat threw the apples at a fast rate in a warmer climate.

Methods: Mealworms were evenly distributed in twelve tupperware cups. Apples were cut into cubes and were placed into the cups along with the mealworms. Six cups were placed into a refrigerator and kept at 25°C and the other six were placed onto a heating pad kept at 70°C. Each day we took down data, seeing how much the mealworms have eaten the apple. We did this for a week.

Conclusion: We found by our data that the mealworms ate the apple at a faster rate in a warmer climate. So, we accept our alternate hypothesis. The mealworms in the warmer climate ate the apples at about a couple of inches per day, while the mealworms in the colder climate ate the

apples at about less than an inch per day.

### **Species Diversity and Abundance Along a Moving Creek Vs. a Still Lake**

BIOL 152 - Tyler Barron ([tboneporkey444@yahoo.com](mailto:tboneporkey444@yahoo.com)), Teresa Fodge ([tfodge@mail.csuchico.edu](mailto:tfodge@mail.csuchico.edu)), Eddie Huebbe ([digitalbuddha48@sbcglobal.net](mailto:digitalbuddha48@sbcglobal.net)), Meghan Warthen ([nut\\_meg-313@sbcglobal.net](mailto:nut_meg-313@sbcglobal.net))  
Faculty Member: Darhl Whitlock [dwhitlock@csuchico.edu](mailto:dwhitlock@csuchico.edu)

It was hypothesized that a community near a moving creek would contain higher species diversity than that of a still lake. This was believed because of better water quality, vegetation, and a protective habitat for every type of occupant. By setting out numerous pit traps in each area, the total number of individuals collected from each community was counted. Also, the different species were classified and recorded. Each of the organisms collected belonged to either the insect or the arachnid family. The order to which each insect belonged was determined by using the Dichotomous Key Classification System. After calculating the Shannon and Simpson index for each area, it was found that the creek area did indeed produce a larger and more diverse sample of species, proving the hypothesis to be correct.

### **Ecological Gradient Analysis of Habitat Variation and Ecotones in Association with Species Diversity at Upper Bidwell Park, Horseshoe Lake**

BIOL 152 - Robert Bruan ([iamrob11@yahoo.com](mailto:iamrob11@yahoo.com)), Kyra Eastman ([km\\_eastman@yahoo.com](mailto:km_eastman@yahoo.com)), Sergio Romero ([serromero11@yahoo.com](mailto:serromero11@yahoo.com)), Aryn Shidi ([ashidi@mail.csuchico.edu](mailto:ashidi@mail.csuchico.edu)), Virginia Willis ([vwillis@mail.csuchico.edu](mailto:vwillis@mail.csuchico.edu))  
Professor Dr. Chris Ivey [ctivey@csuchico.edu](mailto:ctivey@csuchico.edu)

Biodiversity plays a large role in the ecological gradients of terrestrial habitats that are near one another. The combination of local climate conditions, physiological needs of organisms, and biotic interactions among taxa, effect and help determine the biodiversity of a location. Our results from the near lake to far upland gradients show that species belonging to Hymenoptera, Coleoptera, Arachnidia, and Collembola were most prominent in our field of study. The initial findings appeared to show that the far upland habitat had the greatest biodiversity. However, overlapping standard deviations and statistical analysis done via ANOVA, which returned a P-value of 0.085 with an alpha of 0.05, showed no statistical difference in habitat diversities among our five different habitats.

### **Bacterial Growth on Beer with Varying Alcohol Percentages**

BIOL 152 - Justin Chambers, Katherine Forslund, Brian Pritchard, Corey Thomas  
Professor Dr. Chris Ivey [ctivey@csuchico.edu](mailto:ctivey@csuchico.edu)

This experiment was set up to observe bacterial growth on various beers, with differing alcohol percentages. The three observed beers were Sierra Nevada Pale Ale (5.6%), Crystal Wheat (4.4%), and Summerfest (5.0%). Vodka was used as a control, due to its extremely high alcohol

percentage of 40%. The prediction was that the bacteria would grow best in the alcohols with the least percentage. However, the results indicated that there was no growth, and most of the alcohol evaporated by the fourth day. This obstruction in the experiment made it difficult to interpret differences between the four samples. We concluded that bacterial growth may occur on the beer but more specific requirements must be adjusted. Also, after further research we learned that very specific bacteria known as *Pectinatus frisingensis*, grows commonly on beer but mostly under certain pH regulation and anaerobic conditions. Therefore, for further research it may be vital to one cover the samples, two allow a large amount of the sample to sit, and three allow enough time for the sample to grow bacteria.

### **Ecological Gradient Analysis of Insect Diversity in Upper Bidwell Park**

BIOL 152 - Jessica Curry ([thatcurrygirl@yahoo.com](mailto:thatcurrygirl@yahoo.com)), Ershely Raj ([eraj@mail.csuchico.edu](mailto:eraj@mail.csuchico.edu)), Fatima Uribe ([fatiaur@aol.com](mailto:fatiaur@aol.com)), Nicholas Yorton ([magician8642@aol.com](mailto:magician8642@aol.com))  
Ailsie McEnteggart [amcenteggart@csuchico.edu](mailto:amcenteggart@csuchico.edu)

Variations across an ecological gradient often result in variation among insect communities. In order to test this idea we set pit fall traps in varying environments in Upper Bidwell Park; vegetated, slightly vegetated, and desolate. We hypothesized that insect diversity would be greater in more vegetated areas because the vegetation provides the insects with food and shelter that provides protection against possible predators. After determining the Shannon index of diversity for each environment we performed an ANOVA test which caused us to conclude that insect diversity in Upper Bidwell Park is not affected by variations in the amount of vegetation.

### **Frost Resistance of *Aptenia cordifolia* in Varying Soil and Plant Moistures**

BIOL 152 - Lisa Edmiston, Alyssa Marino, Arjun Sandhu, Ashley Schreiber  
Darhl Whitlock [dwhitlock@mail.csuchico.edu](mailto:dwhitlock@mail.csuchico.edu)

The effects of frost on the plant Red Apple *Aptenia*, *Aptenia cordifolia*, was studied under different conditions. There were three different groups of Red Apple *Aptenia*. Each group had six different plants of Red Apple *Aptenia*. Each group was kept in a freezer at 0 degrees celsius for five days. Pictures were taken approximately every 48 hours. Pictures of the first, third, and fifth day were used in the results. The first group of six plants was exposed only to the frost. It did not get watered on its leaves or in the soil. The second group of plants was watered in its soil twice each day. The third group of plants was watered on its leaves twice each day. To make conclusions about the results, we approximated the percentage of plant that died from the frost. This was done for all of the plants (total numbered 18 percentages). The results, supported by the ANOVA and individual graphs of each plant, showed that there was a significant difference in the percentage of death comparing each group of plants.

## **Earthworms Benefit to Seed Germination**

BIOL 152 - Zack Galla ([zgalla@yahoo.com](mailto:zgalla@yahoo.com)), Graham Gooch ([graham\\_gch@yahoo.com](mailto:graham_gch@yahoo.com)), Emese Grek ([egrek@mail.csuchico.edu](mailto:egrek@mail.csuchico.edu)), Edwin Liebig ([eliebig@mail.csuchico.edu](mailto:eliebig@mail.csuchico.edu))  
Dr. Christopher Ivey

In this study we examined the effect earthworms have on seed germination. We took different situations in which various amounts of earthworms per seed were taken into account. We decided to try and eliminate some uncertainty by having five seeds per section of soil, and zero-to-three earthworms per section, we repeated this four times. This way each section could be compared to one another and productivity could be quantified. We hypothesized that the more earthworms per section of soil would mean more productivity of each seed within that soil. Our null hypothesis was that there would be no positive affect on seed germination from earthworms. We concluded that based on our evidence and experiment no benefit to seed germination was detectable from an increased number of earthworms.

## **Measuring the Effects of Juglone from *Juglans nigra* on *Lycopersicon lycopersicum***

BIOL 152 - Alan Hans, Jillian Hostetter, Colin Rowland, and Jafar Sulail  
Dr. Christopher Ivey

*Juglans nigra* is known to produce the chemical juglone, which is allelopathic to other plants. This study is an investigation on the effects of juglone on *Lycopersicon lycopersicum*. Fifteen *Lycopersicon lycopersicum* plants were obtained and treated with varying amounts of soil obtained from under a *Juglans nigra* tree. The rate of leaf decay was recorded and an AONVA analysis was executed to determine that the null hypothesis could not be rejected. During the time frame of the experiment there was not a statistically significant difference in the rate of leaf decay experienced by plants exposed to juglone as compared to those exposed to less or no juglone.

## **Allelopathy in the *Juglans nigra* plant: Effects of the jugone toxin on *Cynodan dactylan***

BIOL 152 - Taranjit Kaur ([taniajr1@yahoo.com](mailto:taniajr1@yahoo.com)), Amy Quarré ([amyquarre@gmail.com](mailto:amyquarre@gmail.com)), and Ashley Vargas ([Ashley02vargas@hotmail.com](mailto:Ashley02vargas@hotmail.com))  
Dr. Christopher Ivey

*Juglans nigra*, the American Black Walnut tree, is known to be allelopathic to many varieties of plants. A Black Walnut tree can inhibit growth in surrounding plants, sometimes completely, and can cause yellowing of the leaves and wilting in plants. The toxin released by the Black Walnut is called jugone, and this toxin is the causative agent in the damage to surrounding plants. In this experiment, we planted *Cynodan dactylan* seeds, commonly known as Bermuda Grass, in regular potting soil and in potting soil mixed with the soil from underneath a Black Walnut tree (n=60). We hypothesized that the grass seeds planted in the regular potting soil would have a shorter germination time than the seeds planted in the Black Walnut mix, and our

null hypothesis was that there would be no difference between the groups. Based on our results, we can reject our null hypothesis, as the grass seeds in the regular potting soil had significantly shorter germination times than the seeds in the Black Walnut mix ( $p < 0.05$ ).

### **A Comparison of Germination Rates of Two Allelopathic Soil Samples**

BIOL 152 - Erika Keshishian ([erika\\_Keshishian@baylor.edu](mailto:erika_Keshishian@baylor.edu)), Crissy Nelson ([pinkladybees@msn.com](mailto:pinkladybees@msn.com)), Breann Peck ([bepeck@hawaii.edu](mailto:bepeck@hawaii.edu)), Rachael Wilson ([horsegrl2000us@yahoo.com](mailto:horsegrl2000us@yahoo.com))  
Faculty: Darhl Whitlock ([DarhlWhitlock@cs.com](mailto:DarhlWhitlock@cs.com)).

Allelopathy is a behavior observed in some plants when they release chemicals into their surrounding environment primarily through their leaves and stems to produce inhibitory effects on surrounding organisms (Rice 1984). Three hundred sixty pink beauty radish seeds *Raphanus sativus* were planted in three different soils to test for allelopathic effects. These soil types were Willowleaf Gum, *Eucalyptus nicholii*, Black Walnut, *Juglans hindsii*, and a control potting soil. The radish heights were later measured, means and standard deviations were calculated, and an ANOVA test was performed using the average height of the radish seedlings. The results of the experiment showed that the pink radishes grew better in the allelopathic soil than the control soil. The ANOVA test, with a p-value of 0.039446 and an alpha value of .05, confirmed that the hypothesis must be rejected. Due to the dispersal mechanism of the allelopathic phytotoxins produced by the trees sampled further research should consider collecting soil samples from trees in their natural environment where the allelopathic chemicals may have the chance to build higher concentrations.

### **Fungi Growing on Yogurt of Varying Quantities of Sugar**

BIOL 152 - Amber Kuykendall ([akuykendall1@csuchico.edu](mailto:akuykendall1@csuchico.edu)), Mark Arguelles ([marguelles@csuchico.edu](mailto:marguelles@csuchico.edu)), Melanie Kim ([mkim10@csuchico.edu](mailto:mkim10@csuchico.edu)), Corrine Vandemaele ([cvandemaele@csuchico.edu](mailto:cvandemaele@csuchico.edu))  
Faculty: Chris Ivey, Darhl Whitlock

The likelihood of bacteria growing on yogurt is minute. The growth on spoiled yogurt reflects a fungal community. Since it is known that fungi grow on yogurt, this experiment was conducted to determine whether yogurts of higher sugar content would be a more hospitable environment for fungi. After eight days of growth, the light yogurt had produced the most colonies of fungi. The control, low fat, and Light and Fit had an extremely small amount of growth. Since there was more than one population, ANOVA was utilized to calculate the statistics for the experiment. The ANOVA statistics verified there is a difference in the growth of fungi on varying sugar contents in yogurt.

### **Redworm (*Eisenia fetida*) effect on Spotted Radish Growth**

BIOL 152 - Kelsey Leas, Jeremy Robinson, Dustin Pesch  
Faculty: Chris Ivey

The null hypothesis concerning the germination rates of the spotted radish with the presence of redworms was rejected. Data was collected measuring the growth rates of twenty radish plants with earthworms and twenty radish plants without earth worms over a period of seven days. The average size of the twenty plants with out redworms was .24 inches with a standard deviation of .036 inches and the average size of the plants with the earthworms was .44 inches with a standard deviation of .050 inches. We can thereby reject out null and come to the conclusion that the worm and worm casings of redworms increases the growth rate of the spotted radish.

### **Ecological Gradient Analysis of Four Habitats in Lower Bidwell Park**

BIOL 152 - Misty McEntee-Choo ([mysti09@yahoo.com](mailto:mysti09@yahoo.com)), Jerry Pin, Andrew Willheim, Blake McSorley

Instructors: C. Ivey, Lab: A. McEnteggart

Biological diversity can be affected by even minor variations across an ecological gradient. Experiment sites in four different habitats in Lower Bidwell Park were examined for their diversity of terrestrial insects. Habitats included: an open field, near a pond, near the creek and under trees away from a water source. It is hypothesized that insect communities in the four habitats are different. The pitfall cup method was utilized. Collected insects were identified and classified by taxonomic order. Data within each habitat and grouped together as an entire ecosystem was graphically analyzed. Count data (raw numbers) vs. relative abundance data (percentage) were contrasted to determine the extent of insect variation within these habitats of Lower Bidwell Park. The two most abundant orders were, Dermaptera and Arachnidia. The relative frequency for the most common orders vs. habitat showed that Dermaptera, Arachnidia, Collembola and Diptera were the four most common orders collected. Based on the Shannon Index average diversity for the four habitats was highest under trees at 1.26 and near the pond at 1.25. Near the creek the Shannon index for diversity was 0.88 and in an open field, 0.79. Data analysis shows that these habitats are not considered to have a significant difference.

### **Invertebrate Diversity in a Near Creek and Far Creek Habitat**

BIOL 152 - Anet Medina ([amedinafuerte@mail.csuchico.edu](mailto:amedinafuerte@mail.csuchico.edu)), Shannon Rich ([srich2@mail.csuchico.edu](mailto:srich2@mail.csuchico.edu)), Zoua Vang ([zvang@mail.csuchico.edu](mailto:zvang@mail.csuchico.edu))

Faculty: Chris Ivey

We conducted our experiment to determine if there would be a higher diversity of invertebrates in wet soil compared to dry soil. After collecting data, we were able to conclude that the wet soil did have a higher diversity based on our calculated Shannon Indexes and Simpson indexes. Methods of this experiment was setting 10 pitfall traps for each of the two sites, near creek and far creek. Used were the Shannon Index, the Simpson's Index of Diversity, and a t test to determined the outcome.

Results of the Shannon and Simpson indexes supported the alternative hypothesis that the near creek had a higher invertebrate diversity than the far creek. However, the t test rejected the alternative hypothesis with a null hypothesis that there would be no differences.

### **Root Length of Winter Vetch *Vicia Villosa* Produced in Riparian Soil and Tuscan Soil**

BIOL 152 - Lane Mullin ([lmullin1@mail.csuchico.edu](mailto:lmullin1@mail.csuchico.edu)), Mai Xiong

([mxiong22@mail.csuchico.edu](mailto:mxiong22@mail.csuchico.edu)), Suaida Yang ([syang28@mail.csuchico.edu](mailto:syang28@mail.csuchico.edu))

Faculty: Chris Ivey, Daryl Whitlock

To compare the root lengths produced in different soils, two sets of twenty Winter Vetch *Vicia Villosa* were collected from two different soil sites of riparian and tuscan in Chico, California. Riparian soils retain more moisture because they are closer to some sort of water source than the tuscan soil. Also, the tuscan soil is drier and harder than the soft riparian soil. The plants collected are to show if plants grown in riparian soil will produce longer root length than plants grown in tuscan soil. The results calculated from the data concluded that plants grown in riparian soil do produce longer root length than plants grown in tuscan soil as our t-calc turned out to be greater than the t-critical.

The experimental hypothesis is to see if plants grown in riparian soil will produce longer root length than plants grown in tuscan soil. Twenty Winter Vetch from each of the two different sites were collected. The roots were dug along with the plants and the distance of the root length was measured in centimeters. A t-test was performed and the t-calc turned out to be greater than the t-critical. Due to this we were able to conclude that plants grown in riparian soil do produce longer root length than plants grown in tuscan soil.

### **Antimicrobial Effects of Garlic from Contaminated Organic Chicken**

BIOL 152 - Ramon Noriega ([noriega.ramon@yahoo.com](mailto:noriega.ramon@yahoo.com)), Jonathan O'quinn

([joquinn@gmail.com](mailto:joquinn@gmail.com)), Mai Xiong ([xengyenglee@yahoo.com](mailto:xengyenglee@yahoo.com))

Faculty: Chris Ivey

This experiment was done to see if garlic would inhibit the growth of bacteria such as salmonella, which is one of the many bacteria found on chicken. We obtained ten plates total; five plates were inoculated with just bacteria from the chicken and the other five plates contained a spread of slurry which was made from four cloves of garlic, and five milliliters of hospital grade sterile water. We used a hockey shaped stirring rod to spread the slurry across the Petri dishes and let them incubate in a green house for 24 hours at 91 degrees F. After incubating for 24 hours, we found that garlic did inhibit the amount of bacterial growth.

### **Ecological Gradient of Invertebrates between California Blue Oak Woodlands and Grassland in Upper Bidwell Park**

BIOL 152 - Rachele Pendergras ([RPendergras@mail.csuchico.edu](mailto:RPendergras@mail.csuchico.edu)) and Jessica Sanck

([JSanck@mail.csuchico.edu](mailto:JSanck@mail.csuchico.edu))

Faculty: Chris Ivey, Daryl Whitlock

The experiment was carried out in order to determine whether or not invertebrate diversity was higher in the California Blue Oak Woodlands, ecotone, or grassland habitat. The experiment was conducted by taking twenty-five cups and collecting invertebrates from five different

habitats: far woodland, mid woodland, ecotone, mid grassland, and far grassland. The ANOVA table was used to calculate the diversity of invertebrates in the different habitats. The calculations showed that there was a p-value of  $4.508 \times 10^{-5}$ , which is lower than the given p-value of 0.05. Because the p-value is lower, there is a significant difference in invertebrate diversity between the Blue Oak Woodlands and the grassland habitats. The null hypothesis can therefore be accepted.

## Upper Division Class Projects

### **Isolation of a nitrogen fixer (*Azotobacter*) the soil collected near the creek.**

BIOL 321 - Ryan Berryman ([ryanberryman@hotmail.com](mailto:ryanberryman@hotmail.com)), Keerthana Chandrakumar ([Keethuthingu@yahoo.com](mailto:Keethuthingu@yahoo.com)), Lauren Sugihara ([Lsugihara@mail.csuchico.edu](mailto:Lsugihara@mail.csuchico.edu)), Ozioma Nwosu ([ozibe2002@yahoo.com](mailto:ozibe2002@yahoo.com))

Sponsoring Faculty Member: Gordon Wolfe ([Gwolfe2@csuchico.edu](mailto:Gwolfe2@csuchico.edu))

Biological nitrogen fixation is a process (discovered by Microbiologist Martinus Beijerinck) that converts atmospheric, molecular, relatively inert nitrogen (N<sub>2</sub>) to a form that is present in organic compounds. In nature this process is carried out by a variety of aerobic bacteria and actinobacteria and some anaerobic bacteria. Some examples of bacteria that fix nitrogen are Diazotrophs, Cyanobacteria, Azotobacteraceae, Rhizobia, Frankia. . The family Azotobacteraceae is of two genera. Azomonas and Azotobacter.

The source of inoculum was some soil new the creek in front of Holt Hall. We made a suspension of this soil with some deionized water. We made some the media specifically for Nitrogen fixers by ensuring it contained no Nitrogen and so organisms that can fix nitrogen would be favored. We used the recipe provided in the Lab manual. We inoculated our plates with some of the soil suspension and incubated at room temperature. Two days later we found growth of two type on the plates. Slide, and gram-staining revealed a mixture of gram positive and negatives. By restreaking we were able to obtain a pure sample of the clear, circular, shiny, colonies. Gram staining revealed that they were gram negative coccus. Phenotypic tests were negative for starch, voges, M.R, Citrate, Indole, endospore and oxidase. Motility, Casein, Lipase, Urease and DNA were positive.

### **The Isolation of Sulfur Oxidizer *Thiobacillus* sp.**

BIOL 321 - Logan Cecil ([logancee@yahoo.com](mailto:logancee@yahoo.com)), Amy Knight ([amknight23@yahoo.com](mailto:amknight23@yahoo.com)), Amy Kingsley ([kingsley3@sbcglobal.net](mailto:kingsley3@sbcglobal.net)), Krista Sowell ([ksowell@mail.csuchico.edu](mailto:ksowell@mail.csuchico.edu))

Sponsoring Faculty Member: Gordon Wolfe ([Gwolfe2@csuchico.edu](mailto:Gwolfe2@csuchico.edu))

Sulfur Oxidizing bacteria of the genus *Thiobacillus* are gram-negative, non-sporulating rods that mostly reside in the alpha, beta, gamma subdivision of Proteobacter. Found in acidic environments, these slow growing organisms are strict aerobes that produce sulfuric acid, creating an acidic environment in which few organisms are capable of living. Utilizing mud samples from Arcata Estuary, Boiling Springs Lake and Wilbur Hot Springs, we enriched with a pre-existing and fresh batch of sulfur oxidizing media (sodium thiosulfate energy source) in an attempt to generate and isolate sulfur-oxidizing bacteria. pH values initially taken from samples were 7 and fell to pH 2-3 after a three-week period suggesting growth. Using a *Thiobacillus* agar, we tried to further isolate our bacteria by modes of streaking. Incubating at 28°C for ~10 days, distinct colony formations were visible macroscopically. Microscopic evaluation of gram stains showed gram-negative rods with accompanied acidophilic fungi. An attempt to grow these organisms in a liquid *Thiobacillus* media resulted with negative feedback. Using sulfur oxide as an alternate energy source, we enriched a separate series of plates in hopes to obtain a sulfur-

oxidizing bacterium without the presence fungi. Our goal is to obtain a pure sulfur-oxidizing sp. that we can better characterize phenotypically and analyze genetically. Currently we are incubating our new plates, hoping there to be an isolated colony worth sequencing.

### **“Nuke Kids on the Block” not the only Radiation Resistant Bacteria in Town**

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Radiation-resistant bacteria such as *Deinococcus radiodurans* are known to survive extended periods of exposure to gamma, UV, and x-rays. This organism is thought to have a very efficient DNA repair system that allows it to survive radiation. *D. radiodurans* has a complex cell wall system and stains gram positive. It has been isolated from a variety of sources such as soil, filtered air, and food items such as ground meat. This organism is also known to be very resistant to drying and its cells always exist as pairs or tetrads. To obtain radiation resistant isolates, a soil sample was obtained from the north side of Holt Hall, suspended in solution and plated on TSA plates. The plates were exposed to up to 30 minutes of UV light and two surviving colonies were chosen for characterization. We are currently evaluating data from a number of phenotypic tests including; gram staining, UV survival, relationship to oxygen, antibiotic resistance, growth on salt, exposure to gamma radiation, comparative nutritional requirements, and desiccation survival. We are also in the process of sequencing 16S rRNA from our isolates. Our goal is to characterize our isolates and determine their identities.

### **Beyond the Pond: Enrichment of Bacterial Halophiles**

BIOL 321 - Cheyenne Humphrey ([chumphrey2@mail.csuchico.edu](mailto:chumphrey2@mail.csuchico.edu)) and Daniele Smith ([dsmith65@mail.csuchico.edu](mailto:dsmith65@mail.csuchico.edu))

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Most halophiles are categorized under the domain Archaea, although some are Bacteria. Euryhaline halophilic bacteria can live in various salt concentrations, ranging from below 3% salt to over 15% salt. Their domains can often overlap with halotolerant organisms. The factors which make these cells tolerant to salt also allows them to live in varying environments in regards to pH, temperature, hydrostatic pressure, and dryness. They use organic-matter as osmotic compatible solutes. Multiple test tubes containing 20% salt TSB were inoculated with a small amount of water from evaporate ponds in Southern California with varying salinity and incubated at 28°C. After two weeks, growth was observed in one series of replicate test tubes, containing inoculum from a pond with 15% salinity, and 10-fold dilutions were performed in an attempt to obtain a pure culture. All dilutions showed good amounts of growth, but based on differential staining it was concluded that the most dilute sample contained a pure culture which was then plated on 20% salt TSA plates. Isolates from the 20% salt TSA plates were re-streaked and the resulting pure culture was plated onto TSA plates of varying salt concentrations (15, 20, 25, 30, and 35%) to determine the salt concentration of optimal growth.

Finally gene sequencing was performed on the isolate using Archaeal and Bacterial primers, showing that the isolate was of Bacterial origin, a Gammaproteobacteria from the genus *Idiomarina*. Final results will be presented at the Department of Biology Poster Symposium.

### **Myxobacterium Isolation from llama dung**

BIOL 321 - David Chuang, Broderick Illa, Catherine Nuetz, Udom Vang  
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Myxobacteria are classified as gram-negative aerobic rod shape bacteria with gliding motility. They have a complex life cycle consisting of myxospores, fruiting body, cyst, and vegetative stages. Their distinguishing feature is that individuals cells tend to aggregate by means of chemotaxis to form swarms for purpose of solid media motility or fruiting body formation under unfavorable conditions. Myxobacterium vegetative cells are predatory bacteria since they produce antibiotics to kill surrounding bacteria and secrete enzymes to lyse then ingest prey. Our method of isolation rely heavily their predatory characteristic. The nutrientless media, should select only for organism able to ingest the lawn of bacteria. The best means of isolation will have to start with acquisition of a pure fruiting body of myxobacteria. We inoculated 1.5% agar noble with about 10mm diameter llama dung on top of a lawn of *P. aeruginosa* or *E. coli* as sole nutrient source. After a weeks incubation in 27° dark room, we note significant yellow/orange coloration surrounding the llama dung. Upon closer observation with dissecting, aside from possible myxobacteria growth, we noticed an abundance of nematode life forms crawling around and competitively ingesting the lawn of bacteria. After a couple week's incubation, our group managed to view a single myxobacterium fruiting body. Ultimately, our goal is to isolate a pure culture of myxobacteria and determine its species based on genetic and phenotypic tests learned in class. Due to unexpected turn of events, our group is currently struggling to acquire a viable myxobacterium fruiting body.

### **Purple needlegrass competition experiment**

BIOL 350 - Miguel Acuna ([macuna2@mail.csuchico.edu](mailto:macuna2@mail.csuchico.edu)), Kyle Arnet ([karnet@mailcsuchico.edu](mailto:karnet@mailcsuchico.edu)), Erin Bowlby ([ebowlby@mail.csuchico.edu](mailto:ebowlby@mail.csuchico.edu)), glenn woodruff ([gwoodruff@mail.csuchico.edu](mailto:gwoodruff@mail.csuchico.edu))  
David Wood ([Dwood@csuchico.edu](mailto:Dwood@csuchico.edu))

Our experiment was designed to test the competitive nature of purple needlegrass with two experimental settings. One purple needlegrass plant was grown in various densities of wheat plants to test how well it grew in competition for resources. The other test we performed simultaneously was to see how the varying degrees of competition which wheat would grow in an environment with heavily saturated soils, and soils with an optimal watering regime for purple needlegrass. We found that purple needlegrass was not significantly affected by the different degrees of wheat density. Likewise, there was no significant difference in the health of the purple needlegrass between the two different watering regimes.

### **Competition between Needlegrass and Wheatgrass with two Variables**

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D. Wood

Purple needlegrass (*Nasella pulchra*) is a California native bunchgrass. We constructed a competition experiment using needlegrass and wheatgrass to see how two variables affected growth. Our variables were density of competitors and degree of shade. We had a control treatment that received 100% light, a light shade treatment that was 30% shaded, and a heavy shade treatment that was 60% shaded. The plants were grown in cups where each cup contained one needlegrass plant. Then we had different samples with no wheatgrass, five wheatgrass plants, 10 plants, 15, 20, and 25. Each cup was watered the same amount and grown in the same environment, other than the experimental variables. Our results for the experiment were not as expected. We found that the control sample and the heavy shaded gave better growth for the needlegrass, while the lightly shaded sample seemed to be affected by competition from the wheatgrass. We concluded that the competitor, the wheatgrass, was strongly affected by the heavy shade. This in turn made it easier for the needlegrass to grow and not be out competed. Using these results, we surmised that shade and density do affect the growth of plants in a competitive environment. Wheatgrass was generally the stronger competitor because it grew so quickly, but given the right circumstances, the needlegrass could thrive instead.

### **Analysis of *Nasella pulchra* (purple needlegrass) growth in sand and clay soils.**

BIOL 350 - Katie Bass ([katie.bass@hotmail.com](mailto:katie.bass@hotmail.com)), William McCall ([wmccall@mail.csuchico.edu](mailto:wmccall@mail.csuchico.edu)), Michael Snow ([snowyball65@hotmail.com](mailto:snowyball65@hotmail.com))  
Faculty: David Wood

*Nasella pulchra* is a native perennial bunchgrass, which was once a dominant species in California. The experimental hypothesis is that soil type will affect the growth of *Nasella pulchra*. *Nasella pulchra* was grown in cups with wheat to simulate competition; the wheat was planted in densities of 0, 5, 10, 15, 20 and 25 per one Np seed. The cups filled with 50% sand or clay and 50% potting soil, and the control was 100% potting soil. The seeds were planted on February 12, 2008 and the plants were allowed to grow for 12 weeks. The plants were watered once to twice a week and received the full amount of sunlight. After 12 weeks the height of *Nasella pulchra* was measured and recorded. An analysis of the *Nasella pulchra* height will determine in which soil type it grows best. The data were analyzed using the ANOVA program in which multiple variables can be calculated at once. The results of ANOVA showed that the variance in soil type was significant to the plants growth but competition with wheat was not. Using excel the means were plotted on a graph which showed that clay had a higher average plant height and was the superior soil for growing *Nasella pulchra*. This research is helpful in plant restoration of local and state wide areas where native grass restoration is important.

## **Effects of Trampling on the California Native Grass *Nassella pulchra* Grown in a Competitive Environment of Varying Densities of Annual Grasses**

BIOL 350 - Nicola Beatts ([purplesky913@yahoo.com](mailto:purplesky913@yahoo.com)), Maria Corrales ([maria.n.corrales@hotmail.com](mailto:maria.n.corrales@hotmail.com)), Melissa Davis ([firstquirk@hotmail.com](mailto:firstquirk@hotmail.com))  
Dr. Wood

The native grasses of California have noticeably been dominated by exotic grasses. The annual grasses seem to be better fit for the environment and are pushing out native grasses such as *Nassella pulchra* or purple needle grass. To determine the effects of competition between an annual such as wheat and purple needle grass the growth was measured by the height of a single seed of purple needle grass with varying numbers of wheat, from 0 to 25. A second factor, of trampling, was also introduced to establish the tolerance of the two species to this aspect. Trampling is common for grasses and could play role in the removal of the native grasses. Two trials of low and high trampling showed that stomping is important in the growth of purple needle grass with a p-value of 0.0004. The density of wheat competitors also affected the growth of the native grasses with a p value of 0.0439. The two dependent variables together created a p value 0.0101 which means that they collectively affected the measured height of purple needle grass. The level of stomping also showed an effect on the height of the purple needle grass with low stomping growing taller. The results show mostly predicted results with some inconsistencies that could be due to the low number of trials and the breakage of pots during the stomping process. Further research is required to confirm results.

## **Interspecific Competition Among Native Purple Needlegrass (*Nasella pulchra*) and a Non-native Annual Wheat (*Triticum aestivum*)**

BIOL 350 - Sanae Burries ([sburries@mail.csuchico.edu](mailto:sburries@mail.csuchico.edu)), Erica Cosio ([ecosio1@mail.csuchico.edu](mailto:ecosio1@mail.csuchico.edu)), Allen Matthews ([bmatthews3@mail.csuchico.edu](mailto:bmatthews3@mail.csuchico.edu)), Mandi McKay ([mmckay2@mail.csuchico.edu](mailto:mmckay2@mail.csuchico.edu)), Sierra O. Sisk ([ssisk@mail.csuchico.edu](mailto:ssisk@mail.csuchico.edu))  
Sponsoring Professor: Dr. David Wood

Interspecific competition for various resources (e.g. water, soil, light, etc.) can be an important factor in determining the distribution and density of species. A Target Neighborhood Design experiment was used to look at two of these variables, water and soil type, on the effect of interspecific competition between purple needlegrass (*Nasella pulchra*), a native perennial bunchgrass, and a non-native annual wheat (*Triticum aestivum*). Two soil treatments, potting soil and sandy soil, were planted with different densities of wheat (0, 5, 10, 15, 20, or 25) with a single needlegrass and then subjected to two watering regimes, drought and no drought. Although there was a minor trend of decreasing needlegrass growth as competitor density increased, the ANOVA analysis revealed that there was no significant statistical difference in the growth of purple needlegrass among any of the treatments. These results indicate that the native grass, *Nassella pulchra*, was unaffected by the levels of interspecific competition in this experiment and was shown to be drought tolerant as well.

### **The effects of water pH and competition density on the growth of *Nasella pulchra***

BIOL 350 - Matt Champion ([mchampion1@mail.csuchico.edu](mailto:mchampion1@mail.csuchico.edu)), Katherine Erickson ([kerickson12@mail.csuchico.edu](mailto:kerickson12@mail.csuchico.edu)), Eric Johnson ([ejohnson40@mail.csuchico.edu](mailto:ejohnson40@mail.csuchico.edu)), Alica Yuen ([ayuen@mail.csuchico.edu](mailto:ayuen@mail.csuchico.edu))  
Dr. David Wood ([dmwood@csuchico.edu](mailto:dmwood@csuchico.edu))

Various environmental conditions can affect the survival and development of organisms. Herein we test the effects of certain environmental factors on *Nasella pulchra* (Purple needlegrass). Individual purple needlegrass plants were exposed to varying densities of wheat plants (*Triticum aestivum*) in order to determine whether or not competition related density affected the growth of purple needlegrass. All plants were then divided into three groups and exposed to water with either the pH of 4, 7, or 10, to determine if varying pH levels would have an effect on purple needlegrass growth within a competitive environment. There was a significant difference in plant growth between the different pH levels, with the most growth measured in the 10 pH range. There was no statistical difference between the purple needlegrass plants exposed to different densities of competitive wheat grass plants.

### **Selective Herbivory Between Purple Needle Grass and Wheat Grass**

BIOL 350 - Alena Chin-Curtis, Marco Ontiveros, Daniel Poggetti, and Ryan Whitelaw  
Dr. David Wood ([dmwood@csuchico.edu](mailto:dmwood@csuchico.edu))

Experiment in determining relationship between purple needle grass (*Nasella pulchra*) and wheat grass (*Triticum aestivum*) based upon density and simulated selective herbivory. We hypothesized that the needle grass would be more advantageous with less density and more herbivory of the wheat grass. We found no relationship in height difference based upon density alone or in selective herbivory alone. There is a relationship when both aspects are together, but the correlation between the two is uncertain. Further experiments in this relationship would strengthen our inconclusive results.

### **The Effect of Soil Type and Competition of Purple Needlegrass**

BIOL 350 - Patrick Curran ([pcurran@mail.csuchico.edu](mailto:pcurran@mail.csuchico.edu)), Rachel Colonna ([rcaincolonna@mail.csuchico.edu](mailto:rcaincolonna@mail.csuchico.edu)), Sam Dragos ([sdragos@mail.csuchico.edu](mailto:sdragos@mail.csuchico.edu)), Kate Brumfield ([kbrumfield@mail.csuchico.edu](mailto:kbrumfield@mail.csuchico.edu))  
Sponsoring Faculty Member: David Wood ([dmwood@csuchico.edu](mailto:dmwood@csuchico.edu))

We conducted a two factor competition experiment to test the growth of the native purple needlegrass (*Nasella pulchra*) using non-native wheat as a competitor. As a second factor we tested the growth of the needlegrass with two different mixed soil types, one with potting soil and sand, and the second with potting soil, sand, and clay. We planted a single purple needlegrass in paper cups and ran the experiment in the classroom under natural sunlight from the window. We had a control group for each soil type with 0 wheat plants, then varied competition density with 5, 10, 15, 20, and 25 wheat plants. We ran the experiment for 12 weeks and then measured the height of the purple needlegrass for each cup. We found that the purple

needlegrass was generally taller with less competition, but there wasn't a strong difference based on the soil type differences. This experiment showed that the purple needlegrass is tolerant of different soil types but it doesn't compete well with non-native wheat.

### **Title**

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The purpose of this experiment was to study the effect of herbivory on purple needlegrass (*Nasella Pulchra*). The needlegrass was planted in 18 cups. Six cups were planted for a control. After given a chance to grow six of the cups with needlegrass were cut 50 percent and the other six were cut 90 percent. The six cups with the 50 and 90 percent were planted with wheat. One cup for both the 50 and 90 had no wheat planted with them, the rest of the cups were planted with increments of five wheat seeds up to 25 seeds. The variation in the cutting was to represent moderate and high herbivory. The plants were cut once a week for a month. Our data shows that there is not a significant effect of the wheat on the growth of the purple needlegrass (ANOVA,  $p=0.62$ ). The higher herbivory has the most significant effect on the relative growth, and a negative effect on absolute growth. The p-value for herbivory was less than .001. A paired t-test was also conducted for the relative and absolute growth for the 50 and 90 present. There was borderline significance for the absolute growth with a t-calc of .052. With all result gather, some shows that there is no significant effect due to p-value in ANOVA, but has an effect in the higher herbivory due to relative growth and absolute growth.

### **Effect of Soil Depth and Competition on *Nasella pulchra***

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Our experiment explored the competitive fitness of California purple needlegrass (*Nassella pulchra*) to the non-native annual species *Triticum aestivum* (wheat). We used an additive form of the target-neighborhood experimental design to increase the competitor density as well as varied soil depth levels. The water, nutrients, and light levels remained constant for the three groups (control, medium, and short). The density values for the competitive wheat were 0, 5,10,15,20, and 25 in individual containers while the needlegrass number remained constant at one per container. We also varied the soil depth between control - 9cm, medium -4.5cm, and short -2.25cm. We found that there was a statistical significance in both the competition and soil depth analysis. Our data demonstrates the most significant difference occurred with the soil depth variable; *N. pulchra* grew the least in the minimal soil depths. We also found that *N. pulchra* did not tolerate the competitive density of *T. aestivum*.

### **Title**

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BIOL 350 (Wood)

In this experiment, we studied the competition effects of wheat (*Triticum aestivum*), a nonnative species, on the growth of purple needlegrass (*Nasella pulchra*), a California native species. We conducted our experiment by planting one purple needlegrass seedling in cups of tightly packed clay soil, surrounded by different densities (0, 5, 10, 15, 20, 25) of nonnative wheatgrass. The control groups were planted in cups of potting soil. They were all grown using natural light. The results of this experiment showed that neither competition from the wheatgrass nor the clay soil significantly affected the growth of the purple needlegrass.

### **Interspecific Competition of *N.pulchra* and *T. aestivum* In Varying Soil Textures**

BIOL 350 - Ariel Leo, [aloe@mail.csuchico.edu](mailto:aloe@mail.csuchico.edu); Sally Gustavson, [sgustavson@mail.csuchico.edu](mailto:sgustavson@mail.csuchico.edu); Pa Lee, [plee@mail.csuchico.edu](mailto:plee@mail.csuchico.edu), Sarah Chaudhury, [schaudhury@mail.csuchico.edu](mailto:schaudhury@mail.csuchico.edu)  
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The objective of the experiment was to compare the effects of competition using soil variables, between wheat (*Triticum aestivum*), a non-native annual grass, with that of purple needlegrass (*Nasella pulchra*), a native perennial bunchgrass of California. The experimental design was composed of six densities with two soil textures and two replicates. The basic additive design was one *N. pulchra* in every pot, increasing the number of wheat plants in increment of 5. The experimental factor incorporated soil mixtures consisting of 1/3 sand or 1/3 clay mixed with 2/3 loam. We hypothesized that the sand mixture would be more optimal for *N. pulchra* to grow and the effects of competition would be less apparent.

The soil type had no effect on the growth rates of the plant species and the competition density had a significant effect. Our p-value for soil texture was greater than 0.05 so we can reject our hypothesis. It can be concluded that soil textures do not have a direct impact on interspecific competition between *N. pulchra* and *T. aestivum*.

### **Growth of purple needle grass (*Nassella pulchra*) in competition with annual wheat grass (*Triticum aestivum*) in loam and 50:50 soil mixture**

BIOL 350 - Lee Lo ([llo1@mail.csuchico.edu](mailto:llo1@mail.csuchico.edu)), Blanca Palomino ([bpalomino2@mail.csuchico.edu](mailto:bpalomino2@mail.csuchico.edu)),  
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This study attempts to determine the growth of a native California plant species (*Nassella pulchra*) in different soil types in response to competition by a non-native plant (*Triticum aestivum*). The two plant species were planted in loam and a 50:50 mixture of loam and clay in a period of 9 weeks. The needle grass was grown in a stable environment with different levels of wheat grass competition varying from 0-25, with increments of 5 wheat grass in each cup. The controlled group contained loam soil and the 2 experimental groups contained the mixture of loam and clay. The results suggest that there was no negative effect of wheat grass competition on purple needle grass and that purple needle grass showed tolerance to the clay mixture.

### **Effect of soil composition on the growth rate of Needlegrass**

BIOL 350 - Robert Marvin, Amanda Rivas, John Thompson, Maile Short  
Faculty: David Wood

A study was conducted to test the effect of soil composition on the growth rate of Needlegrass (*Stipa calamagrotis*). The soil varied in the volume of sand present. We hypothesized that increasing the amount of sand would decrease the ability of the soil to hold water, which would decrease the availability of water for the plants. We also added a competitor in the form of increasing numbers of Wheat grass (*Triticum aestivum*). Our results suggest that soil composition had no effect on the growth of Wheat grass or Needle grass.

### **Success of *Nassella pulchra* with Competition in Varying Soil Conditions**

BIOL 350 - Karley, J. Miller, Christopher P. Morris, Rachae E. Perkins, Kurtis F. Westbrook  
Department of Biological Sciences, California State University Chico.  
D. Wood

*Nassella pulchra* (Purple Needlegrass), a perennial native California bunchgrass, was previously a dominant species in California, but has become rare due to invasive annual species. Interspecific competition of plant species can have a drastic effect on the survival and success of Purple Needlegrass. This competition is also affected by soil composition, light, and moisture. This study focused on the effects of competitor density, using wheat as a surrogate for the other non-native annual species, and soil composition on Purple Needlegrass. Purple Needlegrass was planted in three soil types including loam, 50%loam/50%sand, and sand with varying densities of wheat as the competitor (0,5,10,15,20,25 individuals). We conducted this experiment in individual Dixie cups in a classroom setting using natural light. The plants were watered as needed. Our results suggest that increased competitor densities lowered the success of Purple Needlegrass, and that the grass grew best in loam soil. These conditions combined had an interactive effect. For restoration to be accomplished, these conditions would need to be addressed.

### **No significant effect of inbreeding in *Mimulus guttatus* on resistance or tolerance to parasitism by generalist holoparasitic plant *Cuscuta europaea*.**

BIOL 369 - Chris Dow, Mandeep Grewal, Kalyn Navone, Dominic Adams, Kevin Harris  
Faculty: Chris Ivey ([ctivey@csuchico.edu](mailto:ctivey@csuchico.edu))

Inbreeding, which is common in plants, causes broad physiological and phenotypic changes, and is known to alter plant defense against herbivory and pathogen infection. We tested the hypothesis that inbreeding in *Mimulus guttatus* also alters defense against parasitism by a holoparasite, *Cuscuta europaea*, using two experiments. First, *C. europaea* seedlings were placed equidistant between self-fertilized (inbred) and outcross-fertilized (outbred) host plants planted in single pots. The Plant Vigor Hypothesis predicts vigorous plants are better defended against generalist natural enemies, so we predicted that inbred plants, which are smaller and grow slowly, would be more likely to be parasitized in these choice trials. Second, inbred and

outbred host plants were planted in individual pots and each was assigned to receive a single parasite seedling or to serve as a control (2 x 2 factorial design). Following the Plant Vigor Hypothesis, we predicted that parasitic plants would grow faster on inbred hosts. We also predicted that tolerance to parasitism, or ability of host plants to grow while parasitized, would be lower in inbred plants. Six of 10 hosts parasitized in the choice trials were inbred ( $P = 0.21$ ). Parasites on inbred hosts were 2.5 times larger, but this was not a significant difference. There was no significant effect of inbreeding on tolerance to parasitism. In summary, although statistical support for our hypothesis fell short of significance, the trends we observed were suggestive that inbreeding in *M. guttatus* reduces resistance, but not tolerance, to parasitism by *C. europaea*.

### **Gene AT2G34060 in *Arabidopsis thaliana* supports maturation of young leaves**

BIOL 409 - R. Appleton, J. Sarinana, R. Berlin, R. Berryman, M. Champion, K. Collins D. Edirisooriya, B. Green, H. Hsu, M. Lee, D. Nayyar, T. Robson, B. Stone, U. Vang, M. Yang, E. Zitello, K. Blee

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There are three classes of peroxidases: class I (prokaryote), class II (fungi), and class III (secretory plant) (Welinder, 1992). Seventy-three class III secretory plant peroxidases have been identified in *Arabidopsis thaliana*. The class III peroxidase genes are important for different functional aspects in plants like, substrate oxidation, generation of reactive oxygen species and regulation of hydrogen peroxide levels. Peroxidases are also involved in lignification to strengthen the cell wall. The supporting roles of each class III peroxidase in whole plant functioning remains unresolved. To begin unveiling these supporting functions we have chosen to investigate the role of peroxidase AT2G34060 by observing when and when the gene is expressed. Predictions were made using microarray data within the public domain after analysis with software application tools at Genevestigator, Plant Cis-Acting Regulatory DNA

Elements, and Regulatory Sequence Analysis Tools websites. To test our hypotheses, leaves from two, four and four week old salicylic acid treated plants were subjected to RNA gel blot analysis. We found that expression decreased as the plant aged from 2 weeks to 4 weeks old in the leaves. We also found that salicylic acid downregulated the expression of AT2G34060 in the 4 week old leaves. Because of the high expression of AT2G34060 in most tissues, it is likely that AT2G34060 is involved in normal plant development. Treatment with salicylic acid resulted in down-regulation of AT2G34060 which suggest that this gene has little involvement in defense in adult leaves. In conclusion, AT2G34060 functions primarily in support of normal plant development.

### **Alkaline Phosphatase Induction in an Unknown Bacterial Species**

BIOL 412 - Lisa Dietrich ([funny\\_girl22684@hotmail.com](mailto:funny_girl22684@hotmail.com)), Michael Snow

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Phosphate is a compound essential to bacteria because it is needed for production of phospholipids, nucleotides, and ATP. In response to phosphate starvation, bacteria must be able to express machinery that allows them to seek and obtain phosphate from an alternate source. *E. coli* have a well understood mechanism for phosphate assimilation. They, and many other bacterial species, induce what is known as Bacterial Alkaline Phosphatase (BAP). Soil bacteria are frequently subjected to low phosphate environments so must have some mechanism for phosphorous assimilation. Using the *E. coli* model, we tested our unknown soil isolate to see if it had the same mechanism for obtaining phosphate as *E. coli* does. Initial differential plating showed that the isolate can grow under phosphate starvation conditions and induce some form of BAP. Kinetic analysis of whole cell extracts found that the unknown bacteria induced expression of a phosphatase when under phosphate starvation, but not under high phosphate conditions as expected. Though a phosphatase was induced in low phosphate environments, the isolate did not induce BAP at the high levels shown by *E. coli*, so further experimentation would be required to determine the nature of this phosphatase.

### **Investigation of Bacterial Alkaline Phosphatase Activity To Assay the Phosphate Starvation Induction in Unknown Soil Bacteria**

BIOL 412 - Tesha Huston, Mandeep Grewal, Peggy Taylor

Phosphate is essential in many metabolic pathways in every bacterium. In response to phosphate starvation some bacteria produce Bacterial Alkaline Phosphatase (BAP) enzyme. This enzyme breaks down phosphate from organic and complex inorganic compounds and makes that phosphate available for the bacteria. Soil bacteria were harvested near Chico Creek and isolated. Growth analysis of isolate on limiting media with 0.075 mM phosphate concentration was done over a three hour period. Bacteria was still growing but had consumed all the phosphate and reached absorbance of 0.15 (A600). However samples used during this time did not show BAP activity. To investigate further at what phosphate concentration BAP activity is induced the bacteria was streaked on plates with phosphate concentrations ranging

from 0.01mM to 5mM. The phosphate concentration of 0.01mM to 0.1 mM induced more BAP activity in the bacteria than the phosphate concentration of 0.5 mM to 5 mM. To investigate BAP activity bacteria was grown in high phosphate concentrations and low phosphate concentrations. No BAP activity was found in either of the whole cell or spheroplast extracts. Location of BAP activity in the bacterial cell could not be isolated. To investigate the presence of BAP protein an SDS page analysis of all four extracts was done. From these series of experiments, the conclusion is that this bacterium does not produce a similar type of BAP activity as *E. coli*. This could be due to a different mechanism involved in these soil bacteria. Different experiments need to be invented to test BAP induction in this particular bacterial isolate.

### **Investigating the spatial distribution of larval fish in Mud Creek, a seasonal tributary of the Sacramento River**

BIOL 432 - Chris Arnett, Casey Collins, Craig Hempling, Megan Layhee, Maggie Lee, Darin Olsen, Mike Skaggs, John Wirt  
Michael Marchetti, advisor

We investigated the spatial distribution of larval fish in Mud Creek, an ephemeral tributary of the Sacramento River, in Butte County. Four drift nets were used to sample larvae in a transverse cross section of the creek over a five day period. A pair of nets was used to compare the number of larvae along the edge of the stream versus the middle of the stream. A second pair of nets was used to compare the number of larvae in the surface waters versus the benthos. Our results indicate no significant difference between edge and middle nor between surface and benthos of the creek. Our findings suggest the spatial distribution of fish larvae in the creek is relatively even throughout the water column. Our results may be tied to a number of factors including the declining rate of discharge over the time of our study, or other environmental factors. Further investigation should be conducted to understand the distribution of larval fish in temporary stream habitats.

### **Habitat Utilization and Selection by Birds in a Low Elevation Foothill Woodland Habitat, with Notes on Avian and Plant Diversity**

BIOL 434 - Jeremy B. Ashe and Tim S. Shaw, Jr.  
Raymond J. Bogiatto, Faculty

We conducted a survey of an avian community within a low elevation foothill woodland habitat in Upper Bidwell Park, Chico, Butte County, California. Our field surveys were conducted from April 2-30, 2008. Our 1 hectare study site was divided into ten 100-meter transects. Each survey began at sunrise and lasted until all transects were surveyed. Our goals were 1) to determine the species composition of both the avian and plant communities within our study area, 2) to calculate a foliage height profile for the vegetation present, 3) to calculate Shannon Diversity values for plant species, foliage heights, and bird species, and 4) to determine if birds use the various plant species and foliage heights randomly or selectively. Our

null hypothesis is that birds do not use plant species or heights selectively. Our results, including data analyses, will be presented on our poster.

**Habitat Utilization and Selection by Birds in a Sacramento River Riparian Forest Habitat, with Notes on Avian and Plant Diversity**

BIOL 434 - Shawn X. Fontan, Jr., Natalie D. Garver, and Mike S. Skaggs  
Raymond J. Bogiatto, Faculty

We conducted an investigation of habitat utilization by the avian community within a riparian forest habitat adjacent to the Sacramento River. In order to determine whether the avian community selectively or randomly utilized plant species six two-hour surveys were conducted at sunrise during the month of April, 2008. Our 1 ha study site was divided into transects used to measure the species composition of the plant and bird communities. Within the transects vegetation measurement points were established in order to calculate foliage height and plant species profiles of the study area. Shannon diversity ( $H'$ ) values for the plant species, foliage height, and bird species were generated to be compared with other habitats. Our null hypotheses state that there is no difference in the utilization of the various habitat components by each bird species relative to the availability of each component within the habitat. The most common bird species in the survey area include spotted towhee, Bullock's oriole, downy woodpecker, cedar waxwing, and western kingbird. Our results will be presented on our poster.

**Habitat Utilization and Selection by Birds within a Chaparral Community, with Notes on Avian and Plant Diversity**

BIOL 434 - James P. Johnson, Chris J. Reisinger, and Liz N. Leyvas  
Raymond J. Bogiatto, Faculty

We conducted a study of habitat utilization by birds within a local Butte County, California chaparral community. Our primary objective was to determine whether birds are using plant species and foliage height intervals selectively, or as they occur within our study area. We also generated Shannon ( $H'$ ) Diversity values for plant species, foliage heights, and avian species within our study site; the relationship between these diversity values will be addressed. Our 1 ha study site was located on the Big Chico Creek Ecological Reserve near Hwy 32, 12 mi east of Chico, Butte County, California. Our site was divided into ten parallel transect lines spaced at 10m intervals. Plant species and foliage heights were quantified every ten meters along each transect, with a total of 100 vegetation measurement points (VMPs). Common plant taxa found along our transects included scrub oak (*Quercus berberidifolia*), and gray pine (*Pinus sabiniana*). The availability of the various plant species and foliage height intervals will be compared with their utilization by each bird species in order to determine whether birds are selectively or randomly using these components of the environment. Our data analysis is ongoing, and the results will be presented on our poster.

## **Habitat Utilization and Selection by Birds of the Big Chico Creek Riparian Forest, with Notes on Avian and Plant Diversity**

BIOL 434 - Matt S. Rogers, Julie M. Shaw, and Sarah Maxey  
Raymond J. Bogiatto, Faculty

We conducted a survey of the Big Chico Creek avian community within a riparian forest habitat in upper Bidwell Park, one half mile south of Horseshoe Lake, in Chico, Butte County, California. Surveys were taken during April and Early May, 2008. Ten parallel transects were constructed at 10m intervals within our 1 ha study site in order to survey both the plant and animal communities. Our goals were (1) to determine the species composition of both the bird and plant communities, (2) to calculate foliage height and plant species profiles for our study area, (3) to generate Shannon Diversity ( $H'$ ) values for plant species, foliage heights, and bird species within our study area, and (4) to determine whether birds are using plant species and foliage heights selectively or randomly; our null hypothesis being that there are no differences in the use of plant species and foliage height intervals by birds, relative to availability within our study area. The most common avian species at our study site included European starling, acorn woodpecker, western scrub-jay, and Nuttall's woodpecker. Our results will be presented on our poster.

### **Characterization of an *E. coli* bacteriophage isolated from sewage**

BIOL 476 - Garret Boone, Cheryl Busse, Matthew Champion, Michael Choy, Noelle Conner, Jennifer Connolly, Devon Digges, Ruwanthika Edirisooriya, Rachel Eidman, Teal Harvey, Hsin-Chin Hsu, Shirley Huffman, Akira Iwami, Jesse King, Kari Kliewer, Pa Lee, John-Richard Lucu-Holtzinger, Kevin Parsons, Rachae Perkins, Jaspreet Rai, Emory Zitello  
Faculty Sponsor: Larry Hanne ([LHANNE@CSUCHICO.EDU](mailto:LHANNE@CSUCHICO.EDU))

Bacteriophage have been shown to control bacterial populations in nature. Many of these bacteriophage have yet to be recognized. The purpose of our project was to isolate and characterize an unknown bacteriophage obtained from a sample of sewage collected from a treatment plant. After enrichment with *Escherichia coli* strain 257, we characterized this bacteriophage using standard microbiology and virology assays: receptor studies, temperature stability, presence of an envelope, burst size determination, and gel electrophoresis analysis of viral proteins. We determined that our phage is non-enveloped, stable at temperatures up to 80°C, strain specific to *E. coli* 257, has a major capsid protein of approximately 46 kDa, and has a burst size of at least 25. Further tests could be conducted to characterize receptor specificity, genome size and structure, replication process, and temporal gene expression.

# Undergraduate Research

## **Glutamate ionotropic receptors and excitotoxic cell death susceptibility linked in mice strains.**

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Results from our lab and others showed that genetic resistance to excitotoxic cell death is intrinsic to neurons. This vulnerability is linked to increased calcium ion permeability via ionotropic and/or metabotropic receptors. Using glutamate induced excitotoxicity; we asked whether the resistance is an effect of differential activation of specific glutamate receptor subtypes. After 3 days *in vitro*, C57BL/6 (B6) and FVB/N (FVB) neuron cultures were treated with increasing doses of Kainic Acid (KA), AMPA, NMDA, or glutamate (Glu). Following a 24 hour recovery period, neuron death was assessed using the LIVE/DEAD staining assay (Molecular Probes, Eugene, OR). To rule out the participation of metabotropic receptors, AMPA, KA, and NMDA were simultaneously blocked with their respective antagonists and then treated with Glu 50  $\mu$ M. The B6 and FVB neurons survived the Glu insult indicating that the ionotropic receptors mediated excitotoxicity. All AMPA and NMDA concentrations resulted in no significant neuron loss in either strain. When both strains were treated with 173  $\mu$ M KA, the B6 remained 90% viable while the FVB dropped to ~75%. Since the glutamate receptor subunit 2 (GluR2) in the AMPA receptors causes them to be impermeable to  $Ca^{2+}$  and thus protects cells from excitotoxicity; a second experiment investigated the receptor subunit composition of AMPA receptors using immunofluorescence. The B6 neurons had an average of 2.880 immunoreactivity/10 $\mu$ m, while the FVB neurons had an average of 2.298 immunoreactivity/10 $\mu$ m ( $p = 0.000497$ ). The GluR2 data suggests that the AMPA receptors may provide the resistance in the B6 strain.

## **Diet of the Barn Owl, *Tyto alba*, in Western North America: A Comparison of Prey Richness and Diversity among populations**

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Raymond J. Bogiatto, Faculty

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I analyzed the diet of barn owls (*Tyto alba*) using regurgitated pellets collected in 2007 from two vastly different environments. One sample (11 pellets) was taken at a desert site near Rodeo, Hidalgo County, New Mexico, and the other sample (15 pellets) was taken from a riparian forest site along the Sacramento River, Butte County, California. Pellets were dissected and sorted; skeletal remains were identified using known specimens from the CSUC Vertebrate Museum; prey identification and quantification was done using cranial elements only. Lists of prey, as well as prey richness and diversity values for each site were compared qualitatively and statistically.

New Mexico prey included woodrats, deer-mice, pocket mice, and kangaroo rats. Sacramento River prey included a shrew, house mice, voles, deer-mice, pocket gophers, one small bird, and one water scavenger beetle. Richness values were 7 at each site, and Shannon Diversity values ( $H'$ ) were 0.658 and 0.702 for the California and New Mexico sites, respectively. There was no difference in these diversity values ( $t = -0.3618$ ,  $df=20.77$ ;  $p>.10$ ).

As the number of potential small mammal prey taxa is quite different at the two sites (California ( $n=14$ ), and New Mexico ( $n=34$ )), my alternate hypothesis predicted higher richness and diversity values at the New Mexico site. As the makeup of the prey community, as well as the relative abundance of prey taxa at the two sites is unknown, determining whether barn owls were foraging opportunistically or selectively was not possible. However, based on the small body size of many prey taxa, and the low richness values, especially in the New Mexico sample, data from this study suggest that barn owls may be foraging opportunistically, taking the most abundant prey items in a non-selective fashion.

### **Enrichment, Isolation, and Characterization of Fungi from Boiling Springs Lake**

Marni Merrill and Gordon V. Wolfe

Department of Biological Sciences, California State University, Chico

Boiling Springs Lake (BSL) in Lassen National Volcanic Park's Warner Valley is a pH 2.2, 52°C geothermal lake that undergoes seasonal cooling, and also receives input of leaf and bark material from the surrounding forest that might be a source of thermophilic fungi with novel enzymes. We prepared enrichments of BSL water using a variety of plant material, and incubated samples at 20, 40, and 52 °C. After 1-3 months we observed mycelial growth on a variety of substrates at all temperatures, although noticeably less at 52 °C. We then plated samples onto BSL-water agar with various C sources, including malt, starch, and methyl cellulose, and incubated these at room temperature and 40 °C. Streak isolates were identified genetically by sequencing 18S rRNA and rRNA-ITS PCR amplicons, and preliminary results suggest a number of ascomycetes, including *Penicillium* sp., *Cladosporium*, and other ascomycetes with low identity to known cultures. We are currently assessing genetic complexity in enrichment samples, and also plan to characterize the growth of novel fungi vs. temperature. An ultimate goal of this work is to screen isolates for novel cellulases or other extremoenzymes.

### **Use of Brewery Waste for the Microbial Conversion of Carbohydrates to Lactic Acid**

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One restriction on the commercial production of lactic acid by microorganisms is the cost of nitrogen and carbohydrate sources. Our research focused on the use of industrial waste as a source for these two ingredients. In order to determine the best lactic acid producing bacteria

we tested four homolactic fermenting bacteria from the genera *Lactobacillus* and *Lactococcus* at 28C and 35C. We found that *Lactobacillus rhamnosus* (ATCC #9595) grown at 35C produced the most L-lactic acid.

Initial studies addressed the use of brewery waste (spent yeast cells) as a nitrogen source for the growth of *L. rhamnosus*. Hop components associated with the spent yeast cells are known to inhibit bacterial growth, therefore pretreatment of spent yeast cells with charcoal (0.1 gm charcoal per 5mL yeast cell suspension) or removal of yeast cell wall material was necessary. In order to release nitrogen from yeast as peptides and amino acids it was necessary to pretreat the spent yeast with heat, base, acid, sonication, mechanical shearing, or salt. A combination of acid and heat resulted in optimal nitrogen release and lactic acid production.

Additional studies addressed the use of other industrial waste (spent barley, rice hulls, and rice bran) as a carbohydrate source. Pretreatment for optimal release of utilizable sugars was acid/heat followed by enzyme treatment (amylase and glucosidase). These studies demonstrate the potential for production of lactic acid solely from industrial waste.

### **Phosphorous Oxidizing Bacteria in Organic Soil vs. Soil with Reduce Phosphorous Compounds**

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It is commonly assumed that phosphorus occurs almost exclusively in the environment as fully oxidized phosphate (primarily  $\text{H}_2\text{PO}_4^-$  and  $\text{HPO}_4^{2-}$ , where the oxidation state of phosphorus is +V). However, developments in the field of microbiology and research on the origin of life have suggested a possibly significant role for reduced, inorganic forms of phosphorus in bacterial metabolism and as evolutionary precursors of biological phosphate compounds. Reduced inorganic forms of phosphorus include Phosphite, Hypophosphite, and Phosphine. Phosphine is used in agriculture as a grain fumigant, while phosphite is a widely used fungicide, herbicide and fertilizer. Based in this information we wanted to know if the number and diversity of bacteria varies among soil environments that have been exposed to such reduced forms of phosphorus compounds compared to those that have not. We tested a traditional field that has been routinely treated with forms of reduced phosphorus, and an organic field that has never been treated with reduced phosphorus compounds. We also tested underneath a corn bin that is routinely treated with phosphine gas.

We found that in each of the 3 locations, the concentration of reduced P oxidizers ranged from  $3 \times 10^4$  CFU/gram soil to  $2 \times 10^6$  CFU/gram soil. This suggests that reduced P oxidation is a very common property among soil bacteria. In addition, concentrations of reduced P oxidizers in reduced phosphorus treated soil were not significantly different from the concentrations observed in the organic field. Nonetheless; the diversity of colony morphologies in each soil type was different.

**Investigation of Coenzyme M Biosynthesis in the Ethylene Metabolizing Bacterium *Nocardioides* sp. JS614**

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Coenzyme M (CoM), a cofactor once thought to be exclusively made and utilized by methanogenic archae in the formation of methane, is now known to play a key role in eubacterial alkene and epoxide metabolism. Previous work in *Methanococcus jannaschii* identified five CoM biosynthetic genes (*comA*, *B*, *C*, *D* and *E*) whose products catalyze the first four reactions of a proposed five-step pathway. Genomic analyses of two CoM-dependent alkene utilizing bacteria (*X. autotrophicus* Py2 and *Nocardioides* JS614) revealed *comA* homologs (*xcomA* and *ncomA*, respectively) downstream of genes for epoxide metabolism. Four ORFs immediately downstream of *xcomA* and *ncomA* show significant homology to each other, and together, may represent CoM-biosynthetic gene clusters. In an effort to provide conclusive evidence for the role of these five genes in CoM biosynthesis, a series of vector constructs have been made that may allow the metabolic engineering of *E. coli* to produce coenzyme M.

# Graduate Class Projects

## **Multi-template PCR as a method for constructing gene reporters in the undergraduate laboratory**

BIOL 611 - R. E. Perkins rperkins@mail.csuchico.edu, B. C. Russell brussell@mail.csuchico.edu, D. R. Cummings, K. A. Kliewer, J. N. Rexius, N. M. Beissel, G. L. Parker, E. D. Zitello, E. J. Johnson, L. M. Campbell, R. H. Appleton, A. K. White, and K. A. Blee.

An upper division biology course used tri-template PCR (Tian *et al.*, 2004, High-Throughput Fluorescent Tagging of Full-Length *Arabidopsis* Gene Products in Planta, Plant Physiol 135:25-38) in the construction of chimeric gene reporters. The goal was to isolate a gene with potential *cis* regulatory regions and insert the coding sequence for yellow fluorescent protein (YFP) 10 to 12 amino acids from the C-terminus of the deduced protein. Students employed two rounds of PCR to generate fluorescently tagged peroxidase genes from the *A. thaliana* genome. The first round of PCR generated three fragments; a fragment corresponding to the promoter and N-terminal portion of the peroxidase coding sequence, a fragment corresponding to the C-terminal portion of the peroxidase coding sequence, and a third fragment with the YFP coding sequence. Each fragment was amplified with primers that possess extensions to provide homology that enabled assembly of the fragments in a second round of PCR. The final product of this tri-template PCR was a full-length peroxidase gene that contained the YFP protein inserted within 10 amino acids of the C-terminus. Three attempts by the students were required to achieve success at the fragment-generating-amplifications. After only a single attempt at assembly of fragments in tri-template PCR reactions, 3 of the 4 student groups were successful at generating fluorescently tagged full length peroxidase genes.

## **An in depth look at the function of peroxidases in *A. thaliana* based on gene expression profiles.**

BIOL 612 - Natalie Beissel, Kristopher Blee, Adam Ferris, Eric Johnson, Kari Kliewer, Akiko Masuda, Garrett Parker, Rachae Perkins, Jaspreet Rai, Jacob Rexius, Brandon Russell, Andrew Simpson, Brandee Stone, Choua Thao, and Andrea White

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The peroxidase genes belonging to the class III secretory peroxidases of *Arabidopsis thaliana* code for multifunctional enzymes. It is hypothesized that these enzymes are involved in nearly all stages of plant growth and development including germination, cell wall maintenance, and host defense from pathogens. Therefore it is difficult to assign a specific role to each peroxidase of the gene family. Our study addresses the potential roles of secretory peroxidase genes in the biology of *A. thaliana*. Spatial, temporal, and host defense expression patterns were studied in 63

of the 73 peroxidase genes using software tools Genevestigator and Cluster to group peroxidase genes based on expression patterns. Six major expression groups were identified through the clustering analysis. Group 1 contains three genes that share expression patterns in plant reproductive tissues. Group 2 and 5 both consisting of seven peroxidase genes, show predominant expression in root structures. Additionally, group three shows similarities to group two in terms of peroxidase expression in roots. Group four has seven genes demonstrating peroxidase expression in all developmental stages with exception to external stimuli. Finally, group six, consisting of three genes, shows peroxidase expression in response to bacterial and fungal pathogens. These data highlight the diverse and various roles peroxidase secretory genes play in plant physiology from root development to senescence. Our work is among the first to identify unique roles for individual members of the peroxidase gene family in plants.

### **Comparison between Invaded and Pristine Food Web Structures of Kauai Freshwater Streams**

BIOL 669 - C. Arnett, H. Bowen, D. Delacroix, R. Desfor, S. Fikes, M. Layhee, E. Layvas, and G. Woodruff

Advisor: M. Marchetti

Stable isotopes of carbon and nitrogen can be used to study ecological relationships within a food web and have successfully been used to examine trophic alterations caused by invasive species. We examined the aquatic communities of three Kauai streams with differing levels of invasion (pristine, intermediate and fully invaded). All aquatic organisms in the streams were sampled and identified to the lowest taxonomic level. Tissue samples were obtained from all taxonomic groups in order to quantify feeding interactions using stable isotopes. Although the stable isotope analysis has not yet been completed (due to issues related to funding the analysis), we observed many differences in the composition of the stream communities. The pristine stream had the highest proportion of native species, the lowest taxonomic diversity, and three estimated trophic positions. The intermediate and heavily invaded streams were found to have several changes relative to the pristine stream including a larger proportion of invasive species, greater taxonomic diversity, and the addition of a fourth trophic level. We hypothesize that the stable isotope results will indicate that introduced species alter both the trophic pathways and functional feeding strategies of native species.

### **Herbivore impacts on fitness can echo greatly & discretely: the effects of herbivory damage on flower performance in *Brassica rapa***

BIOL 672 - Joseph E. Kean – [jekean@jacks.sdstate.edu](mailto:jekean@jacks.sdstate.edu)

Dr. Ivey – [ctivey@csuchico.edu](mailto:ctivey@csuchico.edu)

Plant responses induced by injuries are quite variable, some resulting in chemical defense while others yield compensatory growth. The impacts of herbivory are often studied regarding fitness in terms of seed production. This study examines the impacts of herbivore damage on the quality and quantity of nectar available as well as pollinator response. This was determined to be indicative of fitness based on the importance of fertilization on species survival. The plant being studied was *Brassica rapa*, an invasive species abundant in disturbed areas of California's Central Valley. The test consisted of fifteen pairs of similar plants; one plant in each pair was given a damage treatment and the other remained undamaged as a control reference. The damage was induced using pruning clippers and involved the removal of 50% of all plant material to simulate herbivore damage. A period of 48 hours passed before collecting data to allow the plant to respond to the artificial damage. The damage was shown to negatively affect the amount of nectar that *Brassica rapa* plants produced. This demonstrates the effects that herbivory can have beyond just physical damage on resource producing plant parts. The quality of nectar in terms of sucrose content was not shown to be inhibited by the damage. This implies that a resource trade-off allows damaged plants to continue producing quality nectar.

### **Seasonal fire influences on *Melica californica* flower production in a blue oak woodland**

BIOL 672 - Mark Lynch<sup>1</sup>, John Rowden<sup>2</sup>, Chris Ivey<sup>3</sup>

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Fire can potentially enhance the health of native bunchgrasses that occupy the understory of blue oak (*Quercus douglassii*) woodlands, by reducing interspecific competition with invasive grasses that competitively exclude the adequate use of essential resources detrimental to the development of native bunchgrass species. Post-fire flower production is variable between species and is influenced by plant phenology at the time of burning. California melic (*Melica californica*) is a native perennial bunch grass commonly found in the understory of blue oak woodlands on Big Chico Creek Ecological Reserve (BCCER). We examined the influence of spring and fall burns on spikelet production in *M. californica* the following grow season. Hypotheses tested included (1) Independently spring and fall burns negatively influence the quantity of spikelets produced by *M. californica*. (2) Fall and spring burns have a significantly different impact on spikelet production. The study was conducted on quarter hectare sites in blue oak woodlands on Big Chico Creek Ecological Reserve. Four sites were burned in May 2007, four different sites burned November 2007 and four sites unburned (control). Vegetation was sampled in spring 2008. Independently compared with controls, spring and fall burns negatively impacted spikelet production on *M. californica*. Plants in fall treatments produced significantly less spikelets than plants in spring treatments. Plant phenology and burn timing need to be considered when using fire as a restoration tool in areas *M. californica* is present.

### **Native and exotic plant species richness relationships vary among and within spatial scales**

BIOL 672 - Charles D. McClain, cdmclain@gmail.com

Dr. Christopher T. Ivey, ctivey@csuchico.edu

Species diversity relationships between ecological groups occur in patterns that vary with scale. A large body of evidence supports the hypothesis that native and exotic species richness are positively correlated at large spatial scales and negatively correlated at small spatial scales. Native and exotic species tend to co-occur at large scales due to spatial heterogeneity and exclude one another at small scales through competition. I conducted a study to determine if these relationships hold true at restored riparian forests along the floodplain of a large river. I found native and exotic species richness were positively correlated at a large scale (> 50 ha), but the relationship varied among sites at smaller scales ( $\leq 50$  ha). My research provides support for the hypothesis that native and exotic species richness relationships change with scale, however it does not support the hypothesis that species richness relationships are negative at small scales ( $10^{-6}$  ha). If changes in the relationship between native and exotic species diversity can affect the invasibility of plant communities, then understanding these relationships at several spatial scales will be critical to guiding restoration efforts and improve our understanding of ecosystem dynamics.

#### **Variation in blue oak woodland (an annual dominated plant community) response to fall versus spring fires**

BIOL 672- John Rowden

Dr. Christopher T. Ivey, ctivey@csuchico.edu

Disturbance is a major driving force in plant community composition. In temperate climates, including the grass dominated communities of California, fire is a major source of disturbance. Like most environmental variables there are a number of factors influencing how fire impacts communities including the timing of fires. Previous work has shown that grassland fires tend to favor forbs. However, all of these studies examined response to early season fires (June or earlier). In this study I examined the response of the grass dominated understory of blue oak woodlands to early (June) and late (September) season fires to assess differences in forb and grass response. I found that early season fires favor forbs more than late season fires. This work shows the dynamic nature of disturbance and that it is important to consider a number of variables when assessing response to disturbance. Vegetation is the base of a plant community's trophic system and understanding how it responds to temporal variations in fire generated disturbance is integral to assessing fires overall impact on the community. This study will contribute to future work on blue oak community response to fire.

#### **Origins of *Arctostaphylos* in California elucidated using fossils**

BIOL 672 - Andrew "Andy" Simpson [andy.g.simpson@gmail.com](mailto:andy.g.simpson@gmail.com)

Kristina Schierenbeck ([kshierenbeck@csuchico.edu](mailto:kshierenbeck@csuchico.edu)) and Christopher Ivey ([ctivey@csuchico.edu](mailto:ctivey@csuchico.edu))

*Arctostaphylos* (manzanita) is an evolutionarily diverse shrub genus in the California Floristic Province (CFP), and is the dominant chaparral shrub throughout much of California. Despite its immense biodiversity, the CFP is geologically young, having been formed as a result of global-

scale cooling and drying within the last 15 Ma. Before then, climate in North America was warm and wet, probably similar to modern Costa Rica. I examined fossil collections of *Arctostaphylos* from the University of California Museum of Paleontology (UCMP) toward elucidating the geographic origin and timing of the radiation of *Arctostaphylos* into the CFP. The first verifiable fossils of *Arctostaphylos* appear in Nevada and are from the middle Miocene. *Arctostaphylos* first appears in California during the late Miocene, by which time it had already invaded and diversified within the coast range. These data support the hypothesis that the global cooling and drying that gave rise to the CFP also caused semi-arid climates to appear in Nevada before California. *Arctostaphylos*, a semi-xerophyllic taxon, originated outside of California, but invaded and diversified rapidly as California adopted the semi-arid Mediterranean-type climates that characterize the CFP today.

# Thesis Research

## **The effects of host plant quality and associated vegetation on colonization rates of the Valley Elderberry Longhorn Beetle**

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The Valley Elderberry Longhorn Beetle (VELB, *Desmocerus californicus dimorphus*) is a Federally Threatened insect endemic to the Central Valley that relies on its host plant blue elderberry *Sambucus mexicana*, for all life stages. The Sacramento River National Wildlife Refuge (NWR) was established in part to provide protected habitat for the VELB and to date has planted over 118,000 elderberry bushes on 1115 hectares of restored riparian habitat. The health and status of these elderberry shrubs have not been evaluated, nor has the relationship between shrub health and VELB colonization. Our objectives are to determine the health of planted elderberry shrubs in restoration units planted between 1993 and 2004 and to relate shrub health with VELB colonization. In season one we found that elderberry shrubs in proximity to well developed riparian canopy cover appear to be associated with high amounts of elderberry shrub dead biomass, an index we used to evaluate shrub health. The shrubs with the highest percentages of dead biomass are not successfully colonized by VELB. Season one also suggests relationships between restoration age, shrub health and VELB colonization. The percent of elderberry shrubs with new exit holes was lower in the younger sites, while the amount of elderberry dead biomass was higher in the older sites. Based on variables that appear to be important from season one, we will stratify season two sampling by restoration age and density of associated vegetation. This study will inform future restoration designs to create long term habitat for the VELB and other riparian species.

## **Habitat Characteristics of Yellow-billed Cuckoo in Restored Riparian Forests on the Sacramento River, CA**

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Throughout the western United States there has been extensive loss of riparian habitat resulting from anthropogenic causes. Because of this, many species that are dependent on riparian habitat for various life stages have suffered population declines. The Yellow-billed Cuckoo is one such species, once considered a common breeding bird in the western United States and

now a state endangered species in California. In recognition of many species experiencing declining populations, ongoing riparian restoration efforts are being implemented. Sacramento River National Wildlife Refuge is a major focus of these extensive restoration efforts and Yellow-billed Cuckoos are one a target species in this region. However, little is known about if and how restoration benefits Yellow-billed Cuckoos. Goals of this research are to assess whether Cuckoos are utilizing restored riparian habitat on the Sacramento River, and to identify what factors, including vegetation structure and environmental variables, are associated with Cuckoo presence. A total of 9 birds were detected in the summer 2007 field season with 5 re-sightings. Cuckoo detection always occurred in sites with <50% canopy cover and restoration age varied from 4-14 years since planting. Birds were also detected further north on the Sacramento River than in recent surveys. The 2008 field season will expand to include additional restored sites as well as remnant sites in an effort to determine vegetation structure and environmental variables, such as landscape setting, that are associated with Cuckoo presence. This information will further our understanding of Yellow-billed Cuckoo habitat and inform future restoration design aimed at increasing the population of this species.

### **Binding characteristics of amino acids inhibiting feeding in the marine tintinnid ciliate *Favella* sp.**

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Tintinnid ciliates such as *Favella* sp. are important consumers of algae in the open ocean, but their feeding behavior is not well understood. In this research, I sought to characterize a putative cell-surface receptor specific to small side-chained amino acids, which have been shown to inhibit feeding in *Favella*. Using tritiated amino acids, I found that serine, proline, and alanine, which are potent inhibitors of feeding, bind to the cell soma of *Favella* in a manner consistent with binding to a cell-surface receptor. Binding is rapid, specific, reversible, saturable in the low micromolar range, and shows many similarities to data from feeding inhibition studies. Histidine, which does not inhibit feeding, binds with the same kinetics as proline, alanine, and serine, but with lower affinity. The pharmacology of the binding is complex, and suggests there may be multiple amino acid receptors present. I also found evidence for active transport of amino acids, which has not been previously characterized in *Favella*.

### **Microsatellite Data indicate gene flow among *Platanus* species of the Northern Hemisphere.**

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Hybridization is a primary source of invasive genotypes and has been shown to contribute to the loss of diversity in a number of locally adapted species. Our focus is to quantify gene flow within the ancient genus *Platanus* between the native taxa, (*P. orientalis*, *P. occidentalis*, *P. racemosa*, *P. wrightii*) and the non-native *P. x acerifolia*. *Platanus* is wind-pollinated, and its species readily hybridize. The horticultural *P. x acerifolia* is widely planted for its tolerance to infection and other city stresses, and through hybridization events is endangering the genetic integrity of native *Platanus* populations in already compromised, shrinking riparian

habitats. Sixteen of 28 tested microsatellite primer pairs amplified simple sequence repeat (SSR) loci for all taxa. Four of these loci showed species specific allelic diversity among species and were used to identify the gene flow between urban areas and surrounding native populations of *P. racemosa*. These data will serve as the basis for a larger scale sampling efforts to predict the long-term consequences of gene movement out of *P. X acerifolia* and into their native congeners at the regional and landscape level.

### **Factors that influence spring burn intensity in blue oak (*Quercus douglassii*) woodlands**

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Fire in blue oak (*Quercus douglassii*) woodlands has potential benefits to seedling recruitment and sapling development by removing vegetation that competes for needed resources. Seasonal timing of fire significantly influences burn intensity and plant species response. We examined potential factors (canopy cover, herbaceous cover, plant form) that may contribute to spring burn intensity in blue oak woodlands. Hypotheses tested included (1) Burn intensity is correlated with overstory canopy in spring fires. (2) Percent of understory herbaceous cover influences burn intensity. (3) Plant growth form influences burn intensity. The study was conducted on quarter hectare sites in blue oak woodlands on Big Chico Creek Ecological Reserve. Vegetation was sampled in April 2007, followed by burning in May 2007. Independently overstory canopy and herbaceous cover influenced burn intensity in spring fires though the correlation was strongest with overstory canopy. Burn intensity was greater in open canopy woodlands compared to denser canopy cover where fire intensity increased in variability. Plant form also influenced burn intensity and was greatest in grass dominated sites due to the larger vertical structure of the grasses. A similar comparison with fall burns is currently in progress where the overarching objective is to examine the impacts of seasonal burns in structuring the plant and animal communities associated with blue oak woodlands.

### **Identification and Characterization of Reduced Phosphorus Oxidizing Bacteria from Klamath Lake, Oregon**

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Bacterial oxidation of reduced phosphorus (P) compounds such as, hypophosphite (Hpt, P-valence +1) and phosphite (Pt, P-valence +3) have been limited to a few species. We investigated the presence of the previously characterized *htxA* in Hpt and Pt oxidizing isolates. Sediment samples were plated onto MOPS buffered minimal media containing the reduced P compounds Hpt, Pt, or aminoethylphosphonate (AEpn, P-valence +3) as the sole source of P, in addition to

one of two carbon sources, pyruvate and succinate. The average CFU/g sediment observed on plates containing Pi, Hpt, AEpn, or Pt media were  $3.74 \times 10^5$ ,  $2.91 \times 10^5$ ,  $5.12 \times 10^5$ , and  $7.87 \times 10^5$  respectively. Diversity, determined by observing distinct colony morphologies, on plates containing Pi, Hpt, AEpn, or Pt media were 10, 8, 7, and 7 respectively. Eighteen distinct isolates were identified to the genus level by 16s rRNA sequence analysis. Ten have been identified as diverse Proteobacteria. PCR analyses for the presence of *htxA* in each isolate using *htxA* specific primers revealed that 4 out of 14 yielded a PCR product of the predicted molecular weight of *htxA*. The observed diversity and CFU/g on plates with each reduced P compound were comparable to those observed on plates with media containing Pi indicating that reduced P oxidation is more prevalent in environmental bacteria than previously believed and occurs in diverse bacterial species. PCR analyses suggest that several of the Hpt and Pt oxidizing isolates obtained may possess novel *htxA* genes or perhaps completely novel pathways for Hpt oxidation.

# Notes