Willamette University

Science Collaborative Research Program

Student Presentations

Friday 9/19/2008 – Collins 205

Science Collaborative Research Program
Research Conference
Friday 9/19/2008

1:30-1:50 **David J. Anderson and Robert Beard.** L-NMMA (L-N^G-monomethyl arginine), an inhibitor of arginine-dependent nitric oxide (NO) production, mimics the effects of high temperature on cultured guard cell protoplasts of *Nicotiana glauca*. *(Advisor: Professor Gary Tallman, Biology)*

1:50-2:10 **Kelsey Nakata and Doug Rice.** Influence of exercise training on blood hemostasis. *(Advisor: Professor Michael Lockard, Exercise Science).*

2:10-2:25 **Greg Dixon.** The acute effects of chronic trekking pole use on static and dynamic balance in men" *(Advisor: Professor Julianne Abendroth-Smith, Exercise Science)*

2:25-2:45 **Adam Kotaich and Hannah Vietmeier.** Plant Pollinator Interactions in *Camassia* (Agavaceae). *(Advisor: Professor Susan Kephart, Biology)*

2:45-3:00 **Elyse McEntee.** Definitive Evidence of Photons: Setting up a Quantum Light Laboratory. *(Advisor: Professor Roberta Bigelow, Physics)*

3:00-3:15 BREAK

3:15-3:30 **Kaeli Swift.** Peer to peer photo sharing and field readable tags: a simple powerful tool for citizen science and following marked birds. *(Advisor: Professor Dave Craig, Biology)*

3:30-3:50 **Jena Winger and Kristin Murphy.** The onset and magnitude of cardiovascular drift depends on exercise intensity. *(Advisor: Professor Stasinos Stavrianeas, Exercise Science)*

3:50-4:05 **Colin Harthcock.** The effects of side product formation on the phase boundary of the 3-buten-2-one / water liquid-liquid system. *(Advisor: Professor Chuck Williamson, Chemistry)*

4:05-4:35 **Hannah Wells, Eric Autrey, Maria Savoca and Arley Oddo.** An Interdisciplinary Approach to Quantifying Historical Forest Change in Monmouth Township, Oregon. *(Advisors: Professors Karen Arabas and Joe Bowersox, Environmental and Earth Science)*

4:35-4:50 **Nick Babij.** Ene-Allene Ring-Closing Metathesis (RCM) Reactions. *(Advisor: Professor Drew Duncan, Chemistry)*

4:50-5:05 **Corey Costantino, *Presidential Scholar.*** Toward the synthesis of a helical substrate for allene metathesis. *(Advisor: Professor Drew Duncan, Chemistry)*

5:05-5:20 **Michael Harris.** Synthetic progress toward an organocatalytic asymmetric oxa-Michael cyclization. *(Advisor: Professor Drew Duncan, Chemistry)*

David J. Anderson and Robert Beard. L-NMMA (L-N^G-monomethyl arginine), an inhibitor of arginine-dependent nitric oxide (NO) production, mimics the effects of high temperature on cultured guard cell protoplasts of *Nicotiana glauca*.

(Advisor: Professor Gary Tallman, Biology)

At 38°C, cultured guard cell protoplasts (GCP) of tree tobacco (*Nicotiana glauca*) acquire thermotolerance within 24 h but develop insensitivity to an exogenously applied auxin (1-napthaleneacetic acid; NAA). We hypothesized that L-NMMA would mimic the effects of heat on cultured GCP by limiting cell expansion, preventing cell wall regeneration, eliminating the requirement for exogenously supplied auxin and cytokinin (6-benzylaminopurine) for cell survival, and preventing the G1-to-S cell cycle transition. When treated with L-NMMA (1.0 mM), cultured GCP showed limited growth at 32°C, similar to untreated GCP at 38°C. GCP cultured at 32°C for one week did not require NAA or BAP for survival when cells were treated with L-NMMA, and L-NMMA prevented the G1-to-S cell cycle transition. L-NMMA also prevented activation of an auxin-responsive promoter that is suppressed by sustained high temperature. At 32°C in media containing NAA, GCP transformed with the *BA-mgfp5-ER*, a plasmid containing the *BA* auxin-responsive promoter and the thermostable green fluorescent protein (GFP) gene *mgfp5-ER*, expressed GFP at percentages similar to those of cells transformed with a similar construct containing the CaMV 35S constitutive promoter. At 38°C, in media with or without L-NMMA, *BA* activation was inhibited; less than 1% of cells expressed GFP. At the normally permissive temperature of 32°C in media containing auxin and L-NMMA, transformed GCPs expressed GFP at rates similar to transformants in media lacking auxin and L-NMMA. These data indicate that L-NMMA mimics the effects of high temperature on GCP by inhibiting normal auxin signaling for gene expression.

This work was completed as part of the Science Collaborative Research Program and supported with generous funding from the Mary Stuart Rogers Foundation and the M.J. Murdock Charitable Trust.

Kelsey Nakata and Doug Rice. Influence of exercise training on blood hemostasis.

(Advisor: Professor Michael Lockard, Exercise Science).

***Background*:** Hemostasis is the complex interaction between blood coagulation and fibrinolysis to maintain a healthy vascular system. Coagulation consists of the clotting of fibrin molecules, while fibrinolysis is the breakdown of the clot. Abnormalities in hemostasis are strongly associated with the risk of developing cardiovascular disease. Although exercise training is known to influence the capacity of the coagulation and fibrinolytic systems at rest, it is unclear what effect training has on the acute hemostatic response to stress, specifically vigorous exercise. Acute physical exercise has shown to disrupt hemostatic balance; the regulatory mechanisms, however, remain largely unknown. ***Purpose*:** The purpose of this study was to analyze the acute response upon coagulation and fibrinolytic activity after vigorous exercise in active and sedentary individuals. ***Methods*:** Twelve highly active male Masters athletes (age: 61.6 years) and eleven sedentary (age: 63.6 years) healthy males underwent a 30-minute sub-maximal (75% VO_2MAX) treadmill exercise. Venous blood was obtained at rest and five minutes post-exercise. Enzyme linked immunosorbent assays (ELISA) were used to determine the blood concentrations of protein indicators for coagulation activity (prothrombin fragment 1+2), coagulation inhibition (thrombin-anti-thrombin complex and Protein C), fibrinolysis (tissue-plasminogen activator (tPA) antigen), and fibrinolysis inhibition (plasminogen activator inhibitor-1 (PAI-1) activity.

This work was completed as part of the Science Collaborative Research Program and supported with generous funding from the Mary Stuart Rogers Foundation and the M.J. Murdock Charitable Trust.

Greg Dixon. The acute effects of chronic trekking pole use on static and dynamic balance in men.

(Advisor: Professor Julianne Abendroth-Smith, Exercise Science)

INTRODUCTION

Many hikers use trekking poles, which increase stability and reduce joint forces (Bohne & Abendroth-Smith, 2007). However, the International Mountaineering and Climbing Federation (UIAA) suggests pole use has an adverse effect on acute balance. The purpose of this study was to examine the effects of continuous hiking pole use on acute static and dynamic balance.

METHODS AND PROCEDURES

Nine male experienced hikers participated. A foam pad was used for static balancing. A simulated log was used for the dynamic balancing. Knee angles, stride length and time, arm elevation, and medial/lateral and vertical trunk motion were analyzed. EMG recorded lower back and five leg muscles. Participants performed five baseline trials of the balance tasks. They then walked for 15 minutes with and then without trekking poles (counter-balanced). Five trials of each balancing task were repeated between conditions. RM ANOVAs were used for statistical significance (alpha = 0.05).

RESULTS AND DISCUSSION

Results of the static balance task were not significantly different between conditions. Dynamically, no significant differences were noted for knee angles, stride length or stride times, arm elevation or trunk sway. Statistically significant overall muscle activity was elicited for BF, VL, and the GA. Pairwise comparisons showed differences between baseline and the poling conditions, but not between pole use and no pole use.

SUMMARY

Pole use appears to have no negative effect on subsequent balance tasks; therefore, it is suggested that hikers should continue to use trekking poles while hiking for stability and to lessen forces on the lower extremity.

REFERENCES

Bohne, M. & Abendroth-Smith, J. (2007) Medicine Science Sport and Exercise. 39(1), 177-183.

International Hiking and Mountaineering Federation. (1994). *Official Standards of the UIAA Medical Commission*, (vol. 3).

This work was completed as part of the Science Collaborative Research Program and supported with generous funding from the Mary Stuart Rogers Foundation and the M.J. Murdock Charitable Trust.

Adam Kotaich and Hannah Vietmeier. Plant Pollinator Interactions in *Camassia* (Agavaceae).

(Advisor: Professor Susan Kephart, Biology)

Part I. Insect Pollinator Community Associations Between Sympatric Species Of *Camassia*
In this study we examined the composition of the generalist insect pollinator community associated with populations of *Camassia* (Agavaceae) in the Willamette Valley, Oregon. Two species, *C. quamash* and *C. leichtlinii*, occur in sympatry at the Kingston Prairie study site. We investigated whether visitation from the shared pollinator community differed between these *Camassia* species, which are morphologically similar and able to hybridize, yet remain distinct throughout the Willamette Valley. Surveys conducted over 3 weeks along unispecific belt transects (2m x 60m/species) indicate that overall insect pollinator visitation is 1.5 times greater to *C. leichtlinii* than to *C. quamash*. Moreover, surveys along mixed transects (2m x 50m transects of both co-flowering species) indicate overall pollinator visitation rates to be 2.9 times greater to *C. leichtlinii* than to *C. quamash*. In combination, these results suggest a preference for *C. leichtlinii* by insect pollinators, which is even more apparent when the two species flower concurrently. The overall preference for *C. leichtlinii* is greatly influenced by solitary bees, the most abundant group of insect pollinators. Social bees were less abundant, yet they also showed a similar visitation preference towards *C. leichtlinii*. This preference, which preliminary data suggest is influenced by a higher nectar reward in *C. leichtlinii*, may contribute to pollinator constancy on this species, thus limiting interspecific pollen movement and maintaining species distinctions. However, our current data is inconclusive as to whether a distinct partitioning of the pollinator resource exists between the two sympatric species.

Part II. Pollen Limitation and Relative Pollinator Effectiveness in *Camassia*
The two most prevalent species of *Camassia* (Agavaceae) in the Willamette Valley, C. *quamash* and C. *leichtlinii*, are visited by a wide variety of insects. Previous studies document the behavior and visitation of these putative pollinators, but direct investigations of their effectiveness in ensuring seed production are lacking, nor have scientists established whether pollen limits reproduction in natural *Camassia* populations. To evaluate pollen limitation, which determines the potential for insect behavior to influence plant fitness, we supplemented natural pollen deposition in 1-2m^2 plots of C. *quamash* and *C. leichtlinii* in two prairies near Stayton, Oregon. Although fruit set was lower overall for early flowering C. *quamash* than for *C. leichtlinii*, comparisons of fruit set in supplemented plots to adjacent, natural plots show a small positive effect in both species, suggesting that pollen may limit reproduction. Thus, to investigate the relative effectiveness of the five most common insect taxa, we constructed exclusion cages to control pollinator access to study plots. Data analysis is now in progress, but the experiment is designed to measure differences in stigma contact, fruiting, and seed set in plots accessed by specific insect groups (e.g. solitary bees, honeybees, bumblebees, flies) versus diverse pollinators. Overall, fruit set within all exclusion cages was much lower than in surrounding untreated meadow, likely due to restricted pollinator access. Studies that deepen our understanding of this pollination system will continue to have important implications for the restoration and conservation of this once dominant plant, and more work is needed in this area.

This work was completed as part of the Science Collaborative Research Program and supported with generous funding from the Mary Stuart Rogers Foundation and the M.J. Murdock Charitable Trust.

Elyse McEntee. Definitive Evidence of Photons: Setting up a Quantum Light Laboratory.

(Advisor: Professor Roberta Bigelow, Physics)

This experiment utilized the quantum nature of light to unambiguously determine the existence of photons. A blue diode laser sent light through a downconversion crystal which produced two correlated photons at lower frequencies. The photons were then directed along distinct paths that allowed one photon to be used to mark a photon event. The second photon then passed through a beamsplitter where it could follow one of two paths, it could be transmitted through the beamsplitter or it could be reflected at a ninety-degree angle. If a signal was simultaneously detected for both paths, the light exhibited wave behavior. If a signal occurred for only one of the two paths, the light exhibited particle behavior. Complications arose with the electronics of the experiment so we were unable to finish collecting data. However, the initial data indicated that the light in this experiment exhibited a particle nature. We are confident that once the electronics problem is fixed, we will be able to make a definitive measurement.

This work was completed as part of the Science Collaborative Research Program and supported with generous funding from the Mary Stuart Rogers Foundation and M.J. Murdock Charitable Trust.

Kaeli Swift. Peer to peer photo sharing and field readable tags: a simple powerful tool for citizen science and following marked birds.

(Advisor: Professor Dave Craig, Biology)

Peer to peer photo-sharing web services, such as Flickr, can be extremely useful tools for global communication on behalf of researchers, and bird enthusiasts who are interested in coordinating observations of marked, wild birds. A Flickr 'group' called Birds with Field Readable Markers: Bands, Collars, Rings and Tags (www.flickr.com/groups/505232@N24/) was organized with the aim of collecting bird images with field readable tags derived from Flickr queries. Photographers frequently annotate their records with georeferences, providing important information about the marked bird's whereabouts. In less than 6 months volunteers posted over 500 photos totaling 52 species. Of these species some are more often photographed than others with California Condors being the single best documented species. Swans, Hawaiian Nene, geese, terns, godwits, and plovers are also well documented. In certain species namely the California Condor, Hawaiian Nene and Canada Goose, specific individuals were repeatedly documented. While the National Bird Banding Laboratory remains a vital part of the bird banding process, photo sharing services may provide an additional resource to researchers, offering greater diversity and reliability of reported sightings. In the pursuit of understanding bird behavior, migration, and conservation, photo sharing networks like Flickr, provide an opportunity for people of all interest levels to share observations of wild birds on a global level.

This work was completed as part of the Science Collaborative Research Program and supported with generous funding from the Mary Stuart Rogers Foundation and the M.J. Murdock Charitable Trust.

Jena Winger and Kristin Murphy. The onset and magnitude of cardiovascular drift depends on exercise intensity.

(Advisor: Professor Stasinos Stavrianeas, Exercise Science)

Cardiovascular drift (CVD) is a gradual increase in heart rate during prolonged steady-state exercise. We examined its effects on metabolism on two groups of athletes: competitive cyclists (n=12) and recreational runners (n=10). Each participant performed five tests on their respective modality, 3 days apart: a Maximal Oxygen Consumption (VO_{2max}) test, a Lactate Threshold (LT) test, and 3 prolonged bouts (90 min for cyclists, 45 min for runners) at intensities corresponding to 95%, 100%, and 105% of intensity at LT. Heart Rate, VO_2, and blood lactate were recorded continuously during the first 2 tests, and at 15-min intervals in the other bouts (cyclists). We successfully measured the metabolic cost of exercise during CVD. Our data conclusively indicate the following: 1. The onset of CVD is affected by the intensity of exercise; 2. The amplitude of CVD is greater as exercise intensity increases; 3. Small differences in exercise intensity yield statistically significant ($P<0.05$) differences in Heart Rate (i.e. Figure 1), VO_2, and blood lactate (i.e. Figure 2) for both runners and cyclists.

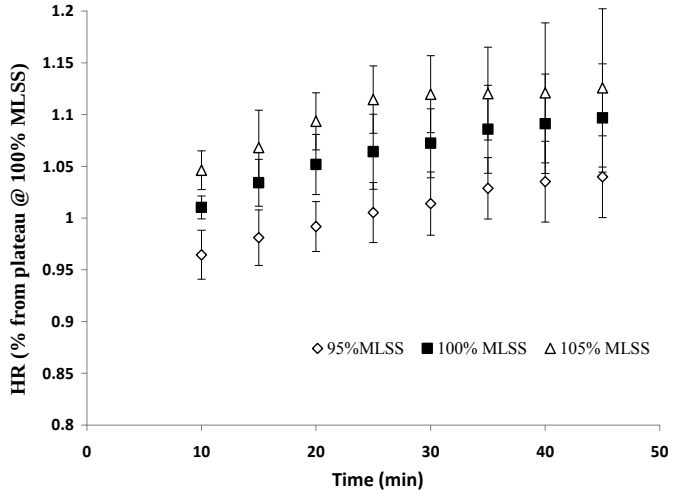


Figure 1. Changes in Heart Rate during prolonged steady-state running at 3 intensities (95%, 100%, 105% of LT.

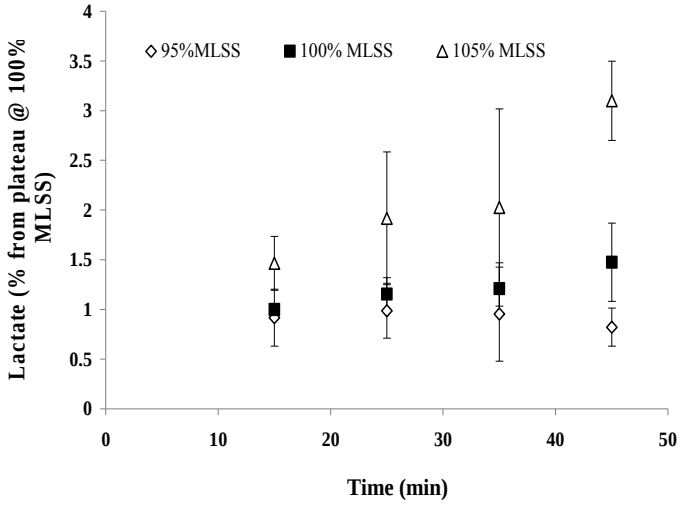


Figure 2. Changes in blood lactate during prolonged steady-state running at 3 intensities (95%, 100%, 105% of LT.

This work was completed as part of the Science Collaborative Research Program and supported with generous funding from the Mary Stuart Rogers Foundation, the M.J. Murdock Charitable Trust, and the National Science Foundation (DUE 0511219).

Colin Harthcock. The effects of side product formation on the phase boundary of the 3-buten-2-one / water liquid-liquid system.

(Advisor: Professor Chuck Williamson, Chemistry)

The phase diagram of the 3-buten-2-one / water liquid-liquid binary system is an interesting one because it is circular. This phase diagram was measured using laser light scattering techniques and the synthetic method. Over time the 3-buten-2-one / water phase boundary changes because this liquid-liquid system forms side products. We studied these effects by doping the system with each side product individually. Hydrolysis products increase the solubility of the system, constricting the phase boundary, while a dimer product is soluble in only the 3-buten-2-one layer and expands the phase boundary. To assess the rate of the cumulative effects of side product formation, we tracked the lower phase transition temperature (LPTT) over time. This was done by taking a sample, equilibrating the sample at one of four temperatures between -20 °C and 78 °C, and measuring the LPTT as a function of time at each temperature. We found that the rate of change in the LPTT increased exponentially with temperature, in agreement with the Arrhenius equation. For our x_{3B2}=0.2778 sample, the rates were as follows: -0.27 mK / hr at -20 °C, -33.3 mK / hr at 25 °C, -283 mK / hr at 50 °C, and -3.610 K / hr at 78 °C.

This work was completed as part of the Science Collaborative Research Program and supported with generous funding from the Mary Stuart Rogers Foundation, and the M.J. Murdock Charitable Trust, and the Willamette University Resource Committee Grant.

Hannah Wells, Eric Autrey, Maria Savoca and Arley Oddo. An Interdisciplinary Approach to Quantifying Historical Forest Change in Monmouth Township, Oregon.

(Advisors: Professors Karen Arabas and Joe Bowersox, Environmental and Earth Science)

This project characterizes and quantifies changes in forest cover between 1850 and 2005 (with emphasis on 1935 to 2005) of 1036 hectares in Monmouth Township, Oregon. Our interdisciplinary approach combines geographic information technology, historical documents, and dendrochronology to investigate the patterns and processes of forest change. Using forest cover values derived from the original land surveys of the 1850s and orthorectified aerial photographs from 1935, 1955, 1978, 1994 and 2005, we digitized forested stands as polygons and calculated their areas to quantify forest cover change between time periods. Our preliminary analysis shows a 29% decrease in forest cover between 1850 and 2005, which is consistent with other research noting the decline in forest cover in the region with the advent of Euro-American settlement. However, our data from the more recent time period (1935-2005) reveal a 39% increase in forest cover. The greatest increase in forest cover occurs between 1978 and 1994 (21%) and the smallest increase between 1955 and 1978 (1%). These results are important because previous studies suggest a continual decline in forest cover since 1850. To better understand the edaphic, ecological, and anthropogenic processes behind these patterns we will: identify forest change by specific types of forest (mixed mesophytic, oak woodland, savanna, industrial-agro forestry); characterize any relationship between vegetation and soils; quantify the degree of forest fragmentation; and examine vegetation change in riparian areas. Using data types and analytic methods from across disciplines we hope to illuminate the natural and anthropogenic drivers of forest change in the Willamette Valley.

This work was completed as part of the Science Collaborative Research Program and supported with generous funding from the Mary Stuart Rogers Foundation and the M.J. Murdock Charitable Trust.

Nick Babij. Ene-Allene Ring-Closing Metathesis (RCM) Reactions.

(Advisor: Professor Drew Duncan, Chemistry)

Ring-closing olefin metathesis (RCM) reactions have led to the synthesis of alkene carbocycles by formation of a new macrocyclic carbon-carbon double bond from two acyclic alkenes. The focus of this research was utilizing this recently developed RCM technology and applying it to synthesize large allene-functionalized carbocycles from ene-allene starting materials. A successful synthesis of the RCM substrate was achieved by coupling a hydroxyalkene tether and aminoallene tether to the pthalic anhydride backbone. Introducing the substrate to varying concentrations of the 1st and 2nd generation Grubbs Ruthenium catalysts did not result in the desired allene functionalized macrocycle. Rather than cyclize as anticipated, the substrate dimerized at the allene end of the molecule, leaving the alkene tether unreacted. This demonstrated the greater reactivity of the allene compared to that of the alkene when using a Ruthenium catalyst. As a result, the continuing research was geared toward developing an aminoallene tether with an additional methyl group attached to the end to provide steric hinderance in the hopes to prevent dimerization and promote cyclization. Upon successful generation of this new aminoallene tether, this synthetic pathway will lead to further investigations regarding RCM reactions involving ene-allenes.

This work was completed as part of the Scientific Collaborative Research Program and supported with generous funding from the Mary Stuart Rogers Foundation and the M.J. Murdock Charitable Trust.

Corey Costantino, *Presidential Scholar.* Toward the synthesis of a helical substrate for allene metathesis.

(Advisor: Professor Drew Duncan, Chemistry)

The relationship between protein structure and function is an essential component of all biological systems. Primary α-helix structures determine much about a proteins character and purpose. Stabilization of α-helix structures through peripheral tethers (macrocycles) has been shown to enhance protein biostability and activity in some instances. Recent investigations have shown that Ring-Closing Metathesis (RCM) reactions can be employed to synthesize macrocycles containing a synthetic α-helical backbone. This research was designed to modify a known α-helical oligopeptide to incorporate a macrocyclic allene functionality, with the goal of studying effects on the resulting stability of the α-helix, and the stereoselectivity of the RCM reaction. Modified allenic alcohols were successfully synthesized from both 3-butyn-1-ol and 4-pentyn-1-ol via the Crabbé homologation. The allenic alcohols were subsequently converted into allenic bromides and tosylates in order to be coupled to the peptide backbone. Unfortunately the reduced electrophilicity of these modified linkers proved enough to disrupt this coupling, despite attempts at different strategies and methodologies to force the reaction proceed. Current efforts are directed towards increasing the reactivity of the peptide backbone, specifically by incorporating a more nucleophilic cysteine residue.

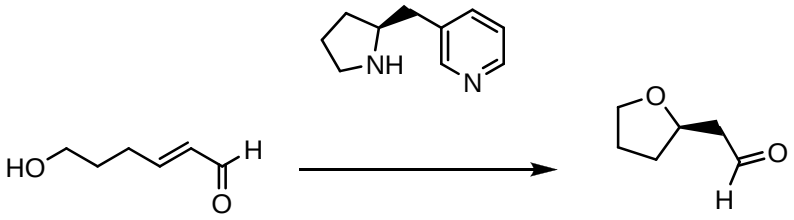
This research is supported through the Presidential Scholarship program, and in part by contributions from the Mary Stuart Rogers Foundation and the M.J. Murdock Charitable Trust.

Michael Harris. Synthetic progress toward an organocatalytic asymmetric oxa-Michael cyclization.

(Advisor: Professor Drew Duncan, Chemistry)

Our research this summer centered on the development of asymmetric organocatalytic oxa-Michael additions. To explore this topic, and to conduct the transformation shown below, *trans*-6-hydroxyhex-2-enal was chosen as our substrate (Figure 1). Three viable synthetic routes were developed to access this compound. The key step in our first route was a Wittig reaction involving 4-hydroxybutanal and formylmethylenetriphenyl phosphate. The second synthetic route utilized cross metathesis by reacting crotonaldehyde and 4-penten-1-ol in the presence of a second generation Grubbs catalyst to give the desired substrate in one step. Spontaneous, uncatalyzed cyclization of the hydroxy enal substrate was a problem with both routes. To prevent spontaneous cyclization, we ultimately used a protecting group strategy in tandem with a Wittig reaction to synthesis our substrate. Synthesis of the pyridyl-pyrrolidine catalyst proceeded first through the formation of a cyclic sulfamidate from (*S*)-(+)-proline and SO_2Cl_2, and then from the ring opening of the sulfamidate by 3-lithio pyridine. In preliminary catalytic studies, the pyridyl-pyrrolidine organocatalyst promoted the conversion of the uncyclized substrate to the cyclized form most effectively when dichloromethane was used as the solvent.

Figure 1



This work was completed as part of the Science Collaborative Research Program and supported with generous funding from the Research Corporation, the Mary Stuart Rogers Foundation and the M.J. Murdock Charitable Trust.