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The Effects of UV Light on Biofilm Formation and Pigment Production of *Janthinobacterium* sp. Strain CG23_2

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Abstract

Organisms found in Antarctica have been shown to possess a variety of mechanisms to persist under low temperatures, freeze thaw events, and UV radiation. An adaptation that bacteria have developed to cope with a variety of environmental stressors, and has been well studied, is biofilm formation. Although stress responses are receiving increased attention, still relatively little is known about the responses of Antarctic bacterial isolates to UV stress. Organisms from supraglacial streams may offer insights to the requirements for the growth of microbes that are adapted to high levels of solar radiation, as they are continuously exposed during the Austral summers. The microorganism selected for this study was isolated from the Cotton Glacier supraglacial stream in Antarctica. The organism is *Janthinobacterium* sp. strain CG23_2, a pigmented, gram negative bacterium. This organism was grown in a CDC bioreactor, and the sunlight simulation was accomplished using a broad spectrum white light, UVA, UVB. The samples were exposed to two different UV treatments, continuous UV radiation and 24 hours of UV light. Samples were collected every 24 hours during the run of the reactor for both biofilm and planktonic analysis. Results indicate that there are differences biofilm formation and pigment production due to UV stress responses. Specifically for *Janthinobacterium* sp. strain CG23_2, the protein and carbohydrate data suggests that increased biofilm formation is a reaction to UV stress. Moreover, the increased pigment abundance per cell is an additional indication of a UV stress response. CLSM showed that there are differences in biofilm structure and cell localization and viability throughout the course of the experiment

Introduction

Ultraviolet light is considered to be one of the most damaging components of solar radiation. UV radiation is divided into three different categories: UVA (315 – 400 nm), UVB (280 – 315 nm), and UVC (100-280 nm) (WHO 2002). UV radiation damages the biological macromolecules such as nucleic acids, proteins and lipids in different ways. Nucleic acids such as DNA undergo cross linking due to the absorption of UV photons (Ravanat 2001). The damage that is caused by high UV exposure is fatal unless the organism can develop a method of protection. UV resistance in bacteria has

been determined to depend on physiological traits such as pigmentation, cell morphology and phototaxis (Jagger 1983).

Organisms found in Antarctica have been shown to possess a variety of mechanisms to persist under low temperatures, freeze thaw events, and UV radiation. A defense mechanism that bacteria use against temperature changes is the production of carotenoid pigments to modulate the fluidity of membranes (Jagannadham, Chattopadhyay et al. 2000). Other mechanisms include the production of cold and heat shock proteins (Gounot 1991). An adaptation that bacteria

have developed, and has been well studied, is biofilm formation. Although stress responses are receiving increased attention relatively little is known about the responses of Antarctic bacterial isolates to UV stress. High amounts of solar radiation are unavoidable for Antarctic microorganisms during the Austral summer. Specifically, supraglacial streams may offer insights to the requirements for the growth of microbes that are adapted to high levels of solar radiation.

Biofilm formation has been proven to be a protective mechanism. Biofilms have been shown to protect against a many different environmental stresses such as, metal toxicity, acid exposure, salinity and dehydration, phagocytosis, antimicrobial agents and UV stress (Hall-Stoodley, Costerton et al. 2004). The development of biofilm has been determined to be regulated by quorum sensing (Juhas, Eberl et al. 2005), and many bacteria produce exopolysaccharides (EPS) in the presence of quorum sensing. It has been suggested that violacein production and biofilm development together are a response to environmental stresses and could possibly be a survival mechanism of *J. lividum* (Pantanella, Berlutti et al. 2007). The two microorganisms that are going to be analyzed for this are *Janthinobacterium* sp. (CG3), a non-pigmented, gram negative bacterium, and *Janthinobacterium* sp. (CG23_2), a pigmented, gram negative bacterium. The violacein pigment production of CG23_2 has been shown to provide protection from UVB and UVC radiation (Mojib, Farhoomand et al. 2013).

Materials and Methods

UV RADIATION

The sunlight simulation was accomplished using a broad spectrum white light, UVA (Phillips Actinic BL PL-L 36W/10/4P 1CT/25), UVB (Phillips PL-L 36W/01/4P 1CT/25). The samples were exposed to 24 hours of simulated sunlight during the initial growth phase.

SAMPLE COLLECTION

The samples were grown in a CDC bioreactor in full strength R2A media for the initial growth. After 24 hours the pump was turned on with a flow rate of 1.67 mL/hr. The inflow media was of a 1 to 10 dilution to induce biofilm production. The bacteria undergo constant shear of 120 rpm. The samples were collected according to Standard Test Method for Quantification of *Pseudomonas aeruginosa* Biofilm (ASTM Standard E2562). Briefly, the rod was removed from the reactor and taken to the sterile sample collection area. Each coupon was removed and the biofilm was scraped into 1 mL of buffered water.

The planktonic samples were taken for the pigment analysis. After the rod was removed from the reactor a sterile pipette was used to collect 10 mL of sample. Once, the sample was taken a sterile rod was placed into the reactor.

CARBOHYDRATE ASSAY

Total carbohydrate abundance was quantified following standard protocols described (citation) using a fluorometric assay. Briefly, each sample has 86% sulfuric acid and L-Cysteine HCl added to it. The sample is then placed in a heat block for 3 minutes at 100°C. The samples are then rapidly cooled and analyzed using a spectrophotometer (OD₄₁₅).

PROTEIN ASSAY

The Qubit Protein Assay Kit (Invitrogen) was used to analyze the total protein content of each scraped sample following manufactures guidelines.

PIGMENT EXTRACTION AND ANALYSIS

Pigments will be extracted from 10 mL of planktonic cells, which will be pelleted via centrifugation 7500 rpm for 20 minutes at 15°C. The supernatant will be removed and 3 mL of 95% methanol will be added

to the pellet. The sample will then be centrifuged for another 20 minutes. The pigment will then be analyzed using a spectrophotometer (OD_{575}) (Mojib, Farhoomand et al. 2013). The absorbance values will then be normalized to the cell abundance (cells/ml) of planktonic cells present in the reactor at the time of sampling (Mojib, Farhoomand et al. 2013).

CONFOCAL LASER SCANNING MICROSCOPY

For imaging, biofilm samples stained for 20 minutes in the dark. Fully hydrated biofilm samples were stained with either SYBR Green, a nucleic acid stain (Invitrogen; Life Technologies) 40 X final concentration or with a live-dead BacLight™ Bacterial Viability Kit stain (Invitrogen™, Eugene, OR) 2 μ M final concentration;. After staining, biofilm samples were rinsed with 0.2 μ m filter sterilized DI water three times to remove any excess stain. Stains were chosen for this study after

comparing a variety of different stains to determine which stains would be the most sample appropriate. Biofilm samples were imaged with a Leica TCS SP5 II upright confocal microscope using either a 25 X water immersion objective, 0.95 NA, WD 2.5mm; or a 63 X water immersion objective, 0.9 NA, WD 2.2mm. Fluorophore excitation lasers and emission bandwidths are as follows:

SYBR Green (ex 497/em 520) 488nm excitation, 500–550nm emission collection; autofluorescence, 561nm excitation, 580–700nm emission. Z-stacks were collected in either 0.54 μ m steps for the 25X objective or 0.64 μ m steps for the 63X objective. remove any biotic material present. previously described. The 3D structure of biofilm samples was reconstructed from the CLSM images using IMARIS software (version 7.6.4).

Results

CARBOHYDRATE and PROTEIN ASSAYS

Carbohydrate and protein abundances for both the 24 hour and continuous UV exposure can be seen in figures 1 and 2.

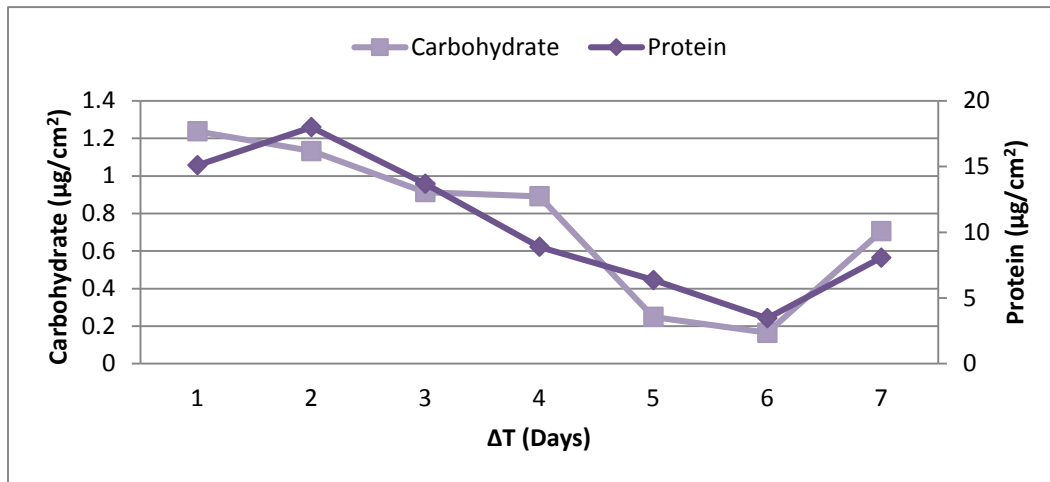


Figure 1: Carbohydrate and protein abundance in biofilm samples for the duration of the reactor run (7 days). Both carbohydrate and protein abundance were normalized to biofilm area which was

calculated from the size of the coupons that they were grown on. Both carbohydrate and protein abundance showed a decreasing trend over time.

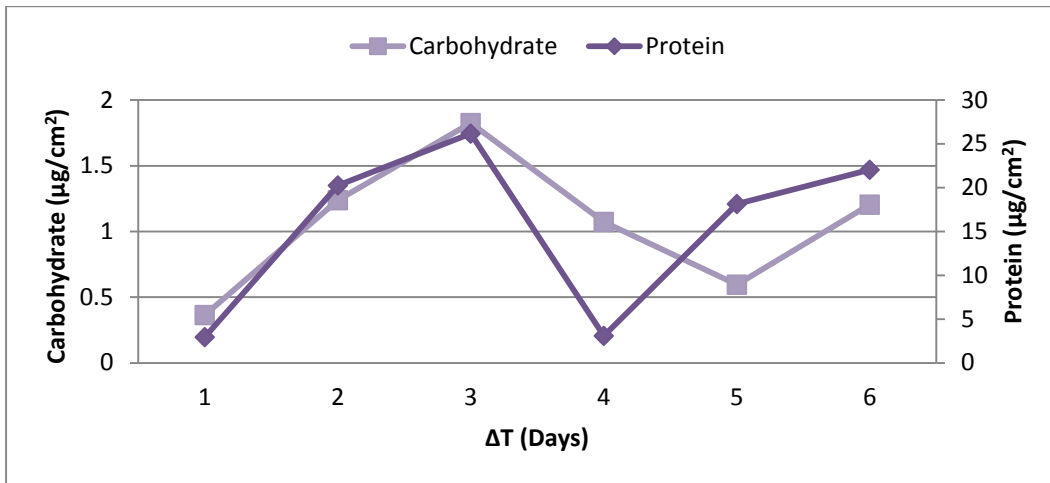


Figure 2: Carbohydrate and protein abundance in biofilm samples for the duration of the reactor run (6 days). Both carbohydrate and protein abundance were normalized to biofilm area, which was calculated from the size of the coupons that they were grown on. Both carbohydrate and protein abundances showed an increasing trend, a washout and another increasing trend over time.

PIGMENT ANALYSIS

Pigment analysis for both 24 hour and continuous UV exposure can be seen in figures 3 and 4.

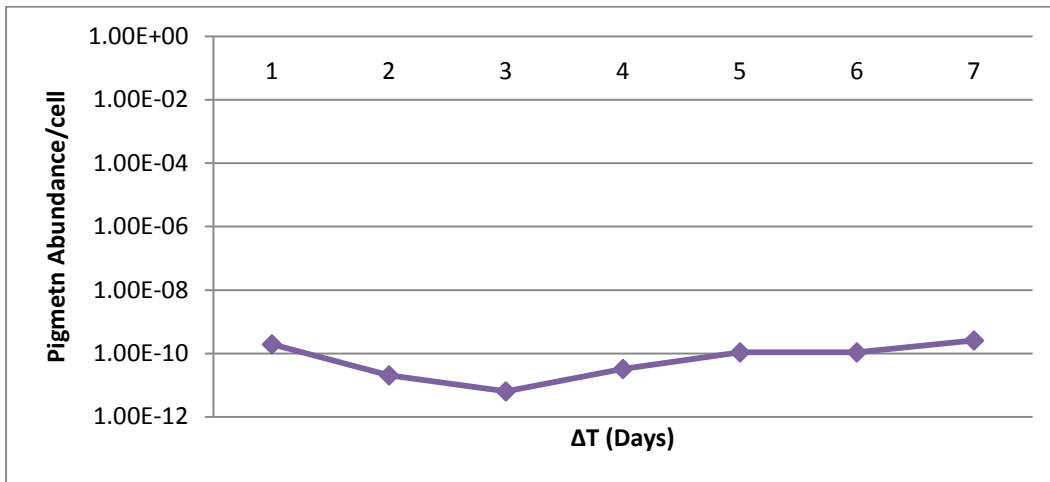


Figure 3: Pigment abundance in the planktonic phase of the reactor. These samples were taken for the duration of the reactor (7 days). Pigment abundance was normalized to cell abundance. Pigment abundance initially decreased, then showed an increase over time.

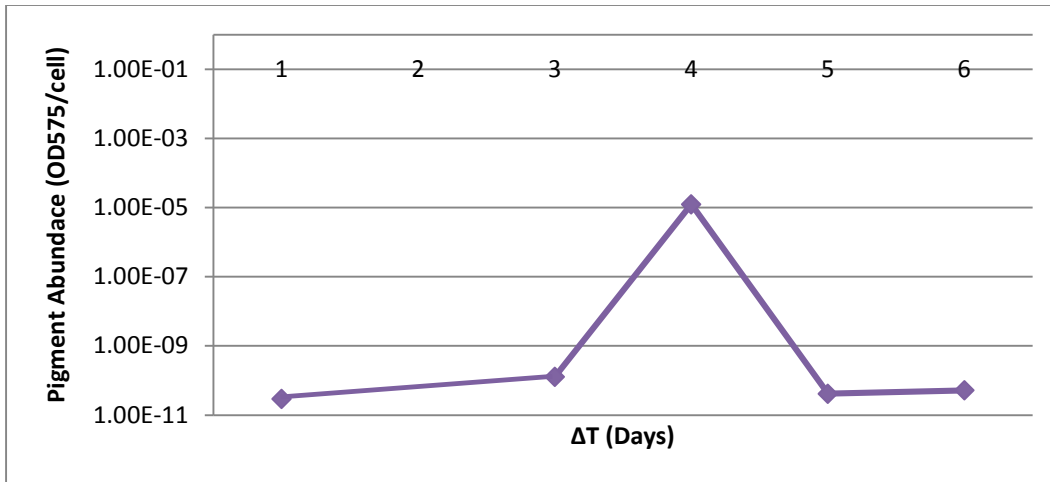


Figure 4: Pigment abundance in the planktonic phase of the reactor. These samples were taken for the duration of the reactor (6 days). Pigment abundance was normalized to cell abundance. Day 2 had such a low abundance that the samples were not taken. Pigment abundance peaked at day four.

CONFOCAL LASER SCANNING MICROSCOPY (CLSM) IMAGES

both taken on day 2 and C and D were both imaged on day 6.

Images of the CG23_2 biofilm at different time points can be seen in figure 5. A and B were

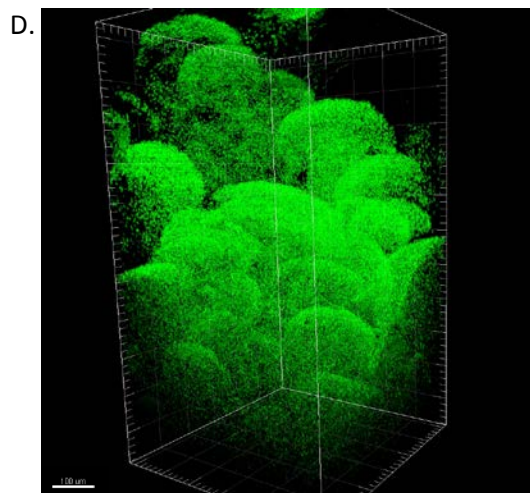
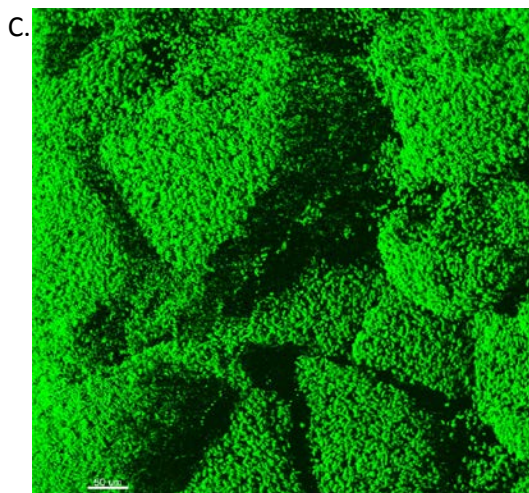
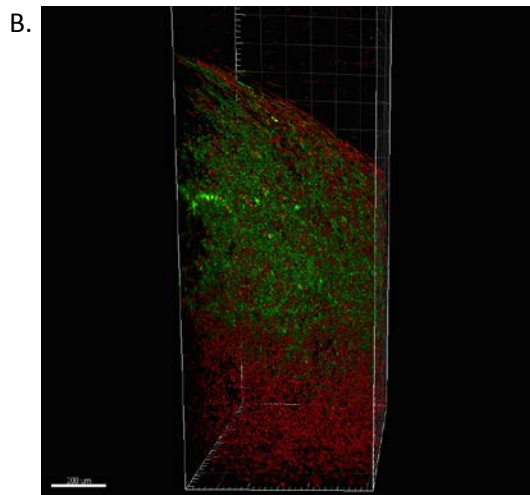
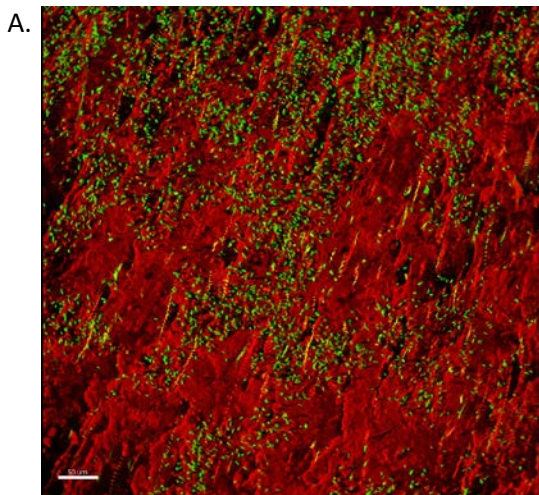


Figure 5: A.) Red= CellMask Orange (final concentration 0.5 µg/ml), Green= SYBR Green (final concentration 40X); scale bar = 50 µm. B.) Red = propidium iodide (final concentration 40µg/ml, Green= SYTO 9 (final concentration 40X); scale bar = 200 µm. C.)3D complied image of the top of the biofilm looking down, Green = SYBR Green (40X); scale bar = 50 µm. D.) Green= SYBR Green (40X); scale bar = 100 µm.

Conclusion

Under the 24 hour UV treatment, this strain of bacteria cannot sustain a substantial biofilm. As seen in figure 1 the biofilm carbohydrates and protein were initially high but time went on without light the carbohydrate and protein levels decreased. The continuous UV exposure carbohydrate and protein levels can be seen in figure 2. The initial levels of both were lower and over time the abundance of both protein and carbohydrates increased. On day three of the reactor run, the carbohydrate and protein levels were at a peak of 25µg and 1.8µg respectively. These high levels of carbohydrates and proteins were never reached under the 24 hour UV exposure. The peak of that reactor occurred at day 1 and the relative abundances were 1.3µg and 15µg.

The pigment abundances were also affected the UV treatments. Under 24 hours of UV exposure the total amount of pigment per cell fluctuated between 1.00×10^{-12} and 1.00×10^{-10} OD₅₇₅/cell. Also, the peak abundance of pigment occurred on day 1 and day 7 and the lowest abundance occurred on day 3. During the continuous UV exposure the pigment abundance fluctuated between 1.00×10^{-11} and 1.00×10^{-5} OD₅₇₅/cell. The peak pigment abundance per cell occurred on day 4 of the reactor run.

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Isolation and Cloning of Zic Family Genes from Chick

Justin Brewer, Daniel Van Antwerp, and Christa Merzdorf

Abstract

Deficiencies or mutations of various genes, particularly those of the *zic* family, lead to a number of birth defects, including anencephaly, holoprosencephaly, and spina bifida. To date, research into the role that *zic* genes play during embryonic development has primarily been done using *Xenopus laevis* and mouse; however, the use of chick embryos offers new possibilities and methods of researching *zic* genes. Since only *zic1* has been isolated from chick, it has not been possible to use chick as a model organism for *zic* gene research. Thus, the objective of this proposal is to isolate and clone the other *zic* genes in chick. Currently, we have isolated liquid pools of *zic3*, have made the reactions more cost efficient, and have begun to investigate *zic4*.

Background and Introduction

One of the key phases in embryonic development is the closure of the neural tube, which develops into the nervous system. This process is regulated by a number of transcription factors. Of particular interest is the *zic* family of genes, a set of zinc finger transcription factors that act as both activators and repressors in neural tube closure.

The *zic* family of genes is essential in the development of the neural tube, left-right asymmetry, and muscle and skeletal development. These genes are also important in the development of the cerebellum. The *zic* genes are first expressed in gastrula development. After signaling molecules inhibit the bone morphogenetic proteins that are present in the cell, the *zic* genes begin influencing neural development. Because bone morphogenetic proteins block *zic* genes, *zic* gene expression cannot begin until the bone morphogenetic proteins are inhibited (Merzdorf, 2007).

The various *zic* genes play different roles in neural development. Early roles in development for each *zic* gene are similar and overlap somewhat. However, mutations in each gene cause different defects. For example, the absence of the *Zic1* gene in mice causes cerebellum malformations and skeletal abnormalities. *Zic2* mutations result in holoprosencephaly, in which the forebrain fails to divide into two structures, causing structures that are on the left and right side of the face to merge into one. Spina bifida has also been linked to *Zic2* deficiency, indicating that *Zic2* is involved in the closing of the caudal neuropore. Deficiencies of the *Zic3* gene have been known to cause abnormalities in left-right asymmetry and neural tube closure defects. *Zic4*, like *Zic1*, has been shown to cause cerebellum malformations similar to *Zic1* deficiency. Finally, *Zic5* gene loss causes neural tube defects (Merzdorf 2007).

To date, most studies of the roles of *zic* genes during development have been conducted in embryos of mice and the frog *Xenopus*. However, since only the *zic1* gene has been isolated from chickens, it has not been possible to make use of chick embryos as a model system for studying the *zic* gene family. Thus, the objective of this research will be to clone the genes for *zic2*, *zic3*, and *zic4* from chickens for use in further lab work.

Chickens are used in this research for several reasons. Because research on human embryos has ethical concerns, model systems are instead used. Model systems need to be easy to maintain, provide accurate results, and provide an accurate comparison between the model and the desired system. Chick embryos present clear, well defined morphology when stained. Chicks also develop in an anterior-posterior gradient of development, allowing various stages of development to be viewed at the same time. Chick embryos are easy to obtain and easy to work with, making them an ideal model organism.

In order to clone the *zic* genes, chick embryo DNA has been used in the form of a cDNA library. cDNA is formed from mRNA and contains only the expressed genes of the organism. Thus, the chicken embryo cDNA library contains cDNAs for all the genes expressed in chicken embryos during development. To make a cDNA library, these cDNAs have been cloned into lambda phages. Lambda phages are specialized viruses that attack bacteria. These phages are used to insert the cDNA into a bacteria array, which clones the DNA.

Methods

- Phage was selected from a chick cDNA library. Library aliquots #2, #10, and #20 were used as samples of the library. Polymerase chain reactions (PCR) and gel electrophoresis were used to screen samples for *zic3*.
- Sample #20 was chosen and diluted to reduce the number of phage particles per sample
- The sample was arrayed into nine wells of a twelve well plate containing *E. coli* bacteria. The plate was placed in 37° C with shaking for 12 hours and then screened for *zic3* by PCR.

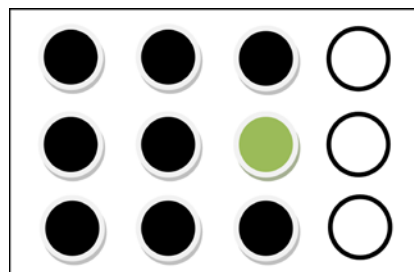


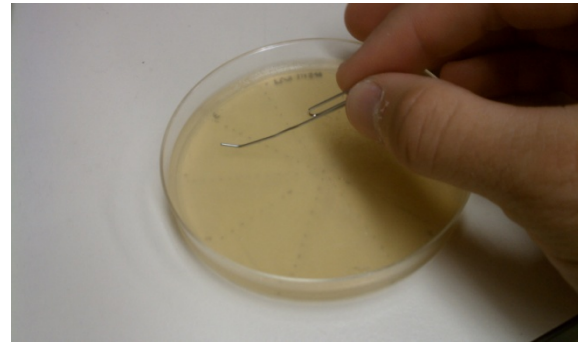
Figure 1: Example of arrayed phage in 9 wells of a 12 well plate. Wells with bacteria are shown in black while wells positive for *zic3* are shown in green.

- The phage from the well with the strongest signal for *zic3* from PCR was purified, diluted, and arrayed into nine more wells of *E. coli* to be screened again.
- Positive wells from the previous test were arrayed and screened for a third time.

- Positive wells will next be plated onto agar plates and allowed to incubate overnight. Phage is then removed from agar plate via a bent paperclip. This is done by dividing the plate into ten sections, lightly scraping the top of each section with a paperclip, and then placing the clip into 100 μ l of water.



Picture 1: Bent paperclip for scraping



Picture 2: Scraping the plate with paperclip

- Phage from solid plate is next tested for presence of *zic3*. Positive tubes are plated again on solid agar medium to reduce number of plaques. This process is to be repeated until the number of plaques per plate has been reduced to a point that individual plaques can be selected.
- Individual plaques will then be removed and tested by PCR for *zic3*. Positive plaques will undergo excision into a useable plasmid.
- Plasmids will be sent for sequencing.
- This process will also be used to isolate *zic2* and *zic4*.

The key step in this process is the dilution of the positive wells after PCR screening. Each dilution of the phage results in a sample that is less complex and more pure than the undiluted samples. By diluting the sample multiple times, the complexity of the phage is reduced significantly.

Results

We have so far completed a number of the steps in this process. We have optimized the PCR reaction, reducing the time per reaction from 3 hours to an hour and a half. From our initial cDNA library phage test, we discovered phage positive for *zic2* and *zic3* from phage sample #20.



Figure 2: Gel electrophoresis picture showing results of phage PCR test. Positive wells for *zic2* can be found in lane 2.1 while positive wells for *zic3* can be found in lane 3.1

We chose to focus on *zic3* first, because it gave the stronger signal in the initial PCR reactions. After multiple rounds of screening in bacteria, *zic3* has been isolated in liquid culture, allowing us to begin plating on solid medium. Phage has been plated on solid medium. We are currently working on reducing the number of plaques per plate by re-plating the phage numerous times and testing by PCR.

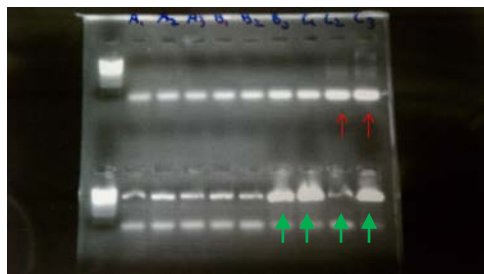


Figure 3: Gel electrophoresis picture showing results of initial *zic3* array. PCR with *zic3* primers is shown at top with positive phage in wells C2 and C3, indicated with the red arrows. PCR with GAPDH primers shown on bottom with positive wells B3, C1, C2, and C3, indicated with the green arrows.

Conclusion

Overall, this procedure has been an effective method to clone *zic* genes in chick. Currently, *zic3* has been isolated in liquid culture and has been plated on solid medium. Once the procedure for *zic3* has been finalized, it will serve as the pattern for the cloning and isolation of the remaining *zic* genes.

This research is important for several reasons. Once the chicken genes for *zic2*, *zic3*, and *zic4* are cloned, they can be used in further research. Because the genes are not currently cloned, it is difficult to use chickens as a model organism. After the genes are cloned, the chick embryos can be used for studying the roles of *zic* genes during neural development and be more accurately compared to the development of other model organisms, which, in turn, will allow us to draw conclusions about human development. Once this is done, we may be able to add to our understanding how neural tube defects form and, eventually, how they can be prevented.

Future Work

Now that *zic3* has been isolated in liquid culture and solid plating has been done, the phage titer will need to be found. *zic3* will be isolated from the solid plates and converted into a useable phage. This phage will then be sent for sequencing. *zic2* will need to be found in liquid culture, plated on solid medium, and cloned. Finally, the PCR primer set and reaction mixture for *zic4* needs to be optimized and *zic4* needs to be identified in the phage library. Once these steps have been completed, *zic4* can be isolated and cloned using the same procedure. Once *zic2*, *zic3*, and *zic4* have been successfully cloned, they can be used in future research.

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The Effect of Glycyrrhizin and its Derivative 18 β -Glycyrrhetic Acid on Clinically Prominent
Bacteria

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Abstract

Due to the increasing antibiotic resistance with bacteria, natural compounds and other alternatives to traditional antibiotics are being pursued. An alternative to antibiotic treatment of clinical bacteria like Methicillin-resistant *Staphylococcus aureus* (MRSA), 18- β Glycyrrhetic acid (GRA) has shown promising results of reduced virulence expression and bactericidal effects on MRSA (1). In these experiments, further tests of GRA were done on bacteria within the *Streptococcus* and *Staphylococcus* genres including: *Streptococcus pyogenes*, *Streptococcus agalactiae*, and *Staphylococcus aureus*. Results obtained from the bactericidal assays of both *Streptococci* species indicate GRA has an antimicrobial capacity against diverse bacterial species but that its efficacy varies among target bacteria. Further research needs to be done in order to further characterize the effect of GRA on different species of clinically relevant bacteria.

Introduction

Antibiotic-resistant microbes represent one of the worst situations within the field of medicine. Due to the high concentration of antibiotics within healthcare, a gradual increase of antibiotic-resistant bacteria continues to threaten both patient treatment and cost within the hospital setting. Due to such a prominent and threatening status, alternative medications and treatments are being researched to avoid antibiotic-resistance complications with bacteria. One of the most hopeful alternatives is the compound glycyrrhizin, specifically its derivative glycyrrhetic acid. The *Glycyrrhiza* species of the licorice family produces the natural compound glycyrrhizin, classified as a triterpenoid saponin (2). When glycyrrhizin is consumed, it is converted by gut flora from its natural, inactive form to 18 β -Glycyrrhetic acid through the process of hydrolysis. This form can then enter in the bloodstream to take effect (3).

As demonstrated in previous experiments, GRA has antimicrobial activity at high doses against MRSA (1). Sublytic concentrations of GRA cause reduced expression of key staphylococcal virulence genes. Topical application of GRA following MRSA skin infection resulted in reduced abscess size, decreased virulence gene expression *in vivo* and modulation of key neutrophil chemokines, KC and G-CSF. However, GA did not demonstrate bactericidal activity; in fact, it seemed to stimulate growth of MRSA colonies, and it did not significantly modulate gene expression in *Staphylococcus aureus* (1). Based on these previous observations, we hypothesized that GRA and GA would demonstrate bactericidal activity in the *Streptococcus* genus of bacteria. To test this hypothesis, two *Streptococci* bacteria were chosen: *Streptococcus pyogenes* (Group A *Streptococcus*) and *Streptococcus agalactiae*. Group A *Streptococci* (GAS) can occur asymptotically in people or display mild to moderate symptoms like “Strep throat”(over 10 million cases per year)—characterized by the inflamed and painfully, purulent-covered tonsils, impetigo—a skin infection characterized by open sores with clear fluid, and toxin-mediated scarlet fever (4). Sometimes, GAS can progress into severe, life-threatening

diseases when it enters organs like the lungs, muscle, and blood. Invasive GAS causes diseases like necrotizing fasciitis that rapidly annihilate tissues of fat and muscle and streptococcal toxic shock syndrome (STSS) that can rapidly drop blood pressure and result in organ failure. These severe forms of GAS disease cause high mortality with more than 25% of patients succumbing to necrotizing fasciitis and 35% of patients to STSS (5). Moreover, GAS is the current leading causative agent of rheumatic fever (6). *Streptococcus agalactiae*, also known as Group B *Streptococcus*, is normally found in the “intestine, urinary, and vaginal tracts of 15-45% of all healthy women” (7). Although it can affect adults, the infection commonly spreads to newborn babies before or during delivery. If GBS infects the fetus, it can cause miscarriages and stillbirths. Symptoms of the infection in neonates include fever, breathing problems, lethargy, and poor feeding (7). Additional complications for infants caused from this bacterium include sepsis, pneumonia, and meningitis, causing a mortality rate of 4-6%. In adults, the infection can cause skin and joint infections; this is associated with mortality rates of 9-47%. This bacterium originally was discovered as a pathogen in dairy cattle that caused bovine mastitis and remains a major cause of economic devastation to dairy farmers (8).

In the current study, the bactericidal efficacy of GRA was tested on bacteria within the *Streptococcus* genus to test the hypothesis that GRA would demonstrate antimicrobial activity towards *Streptococcus pyogenes* and *Streptococcus agalactiae*.

Results

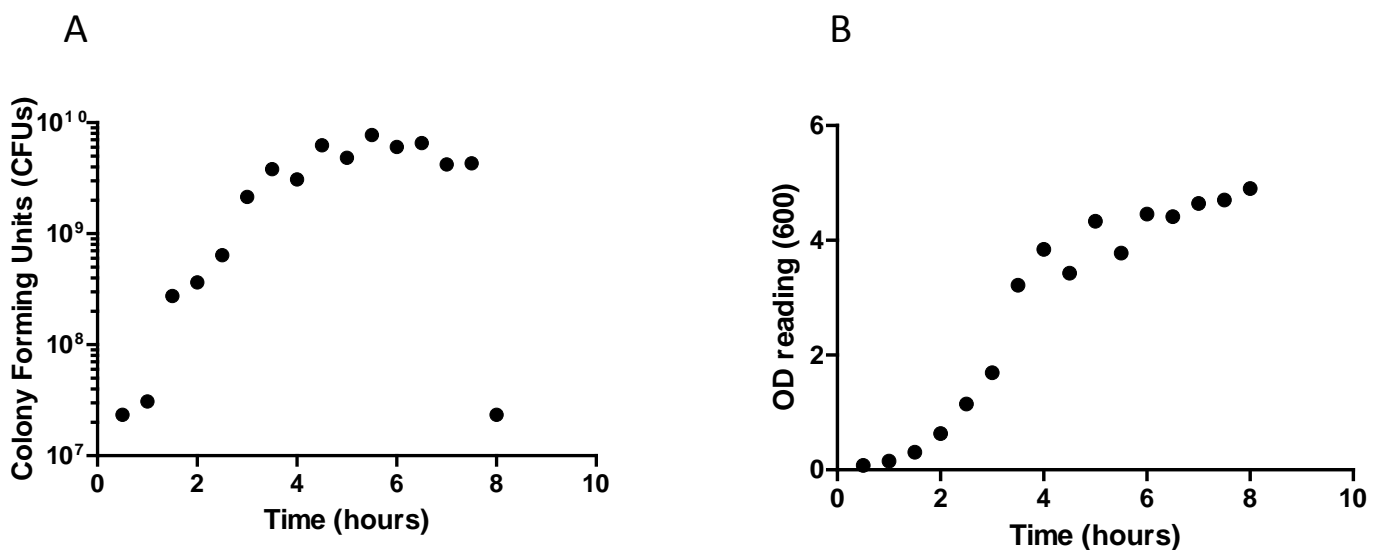


Figure 1. *Staphylococcus aureus* Standard Growth Curve. (A) CFUs were determined by plating TSA and enumerating the colonies on the following day. (B) Optical density (OD600) during an 8-hr interval Data was representative of one experiment.

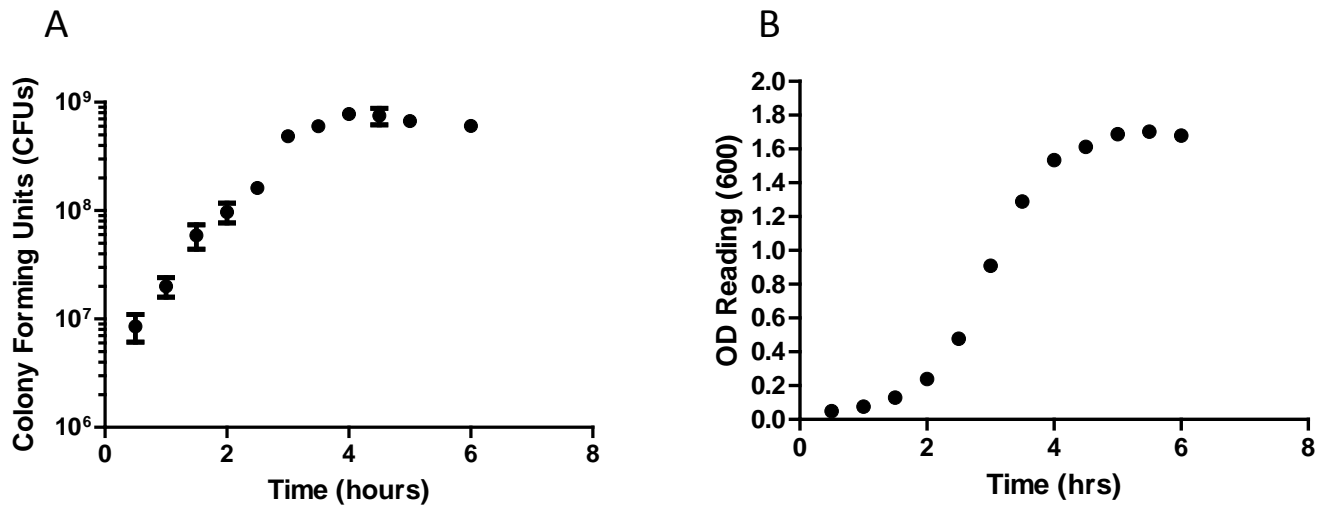


Figure 2. *Streptococcus agalactiae* Standard Growth Curve. (A) CFUs were determined by plating BHI and enumerating the colonies on the following day. (B) Optical density (OD600) during an 8-hr interval. Data was representative of one experiment.

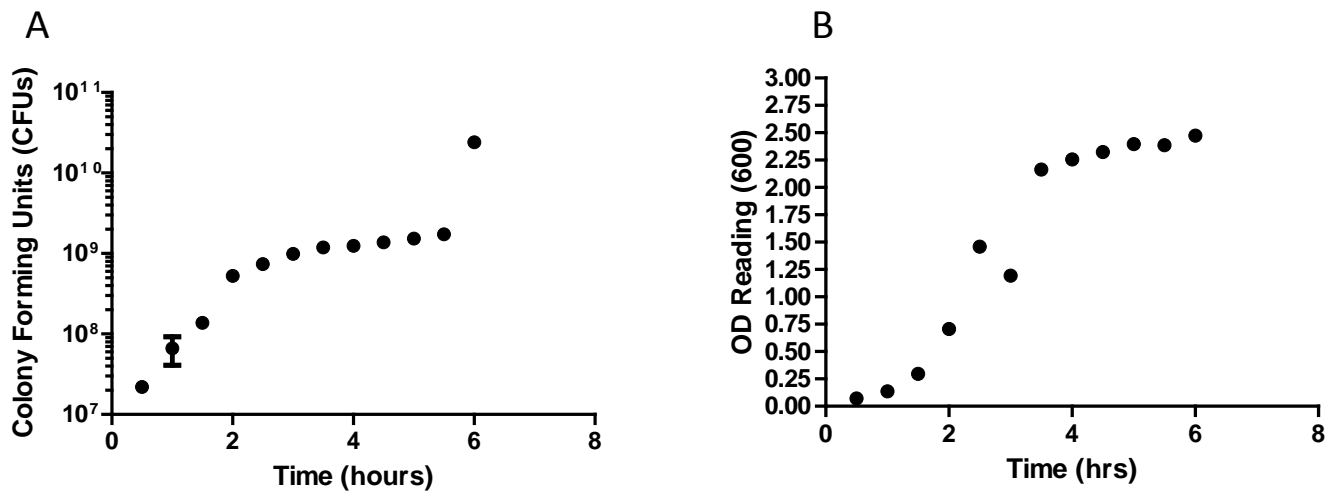


Figure 3. *Streptococcus pyogenes* Standard Growth Curve. (A) CFUs were determined by plating THY and enumerating the colonies on the following day. (B) Optical density (OD600) during an 8-hr interval. Data was representative of one experiment.

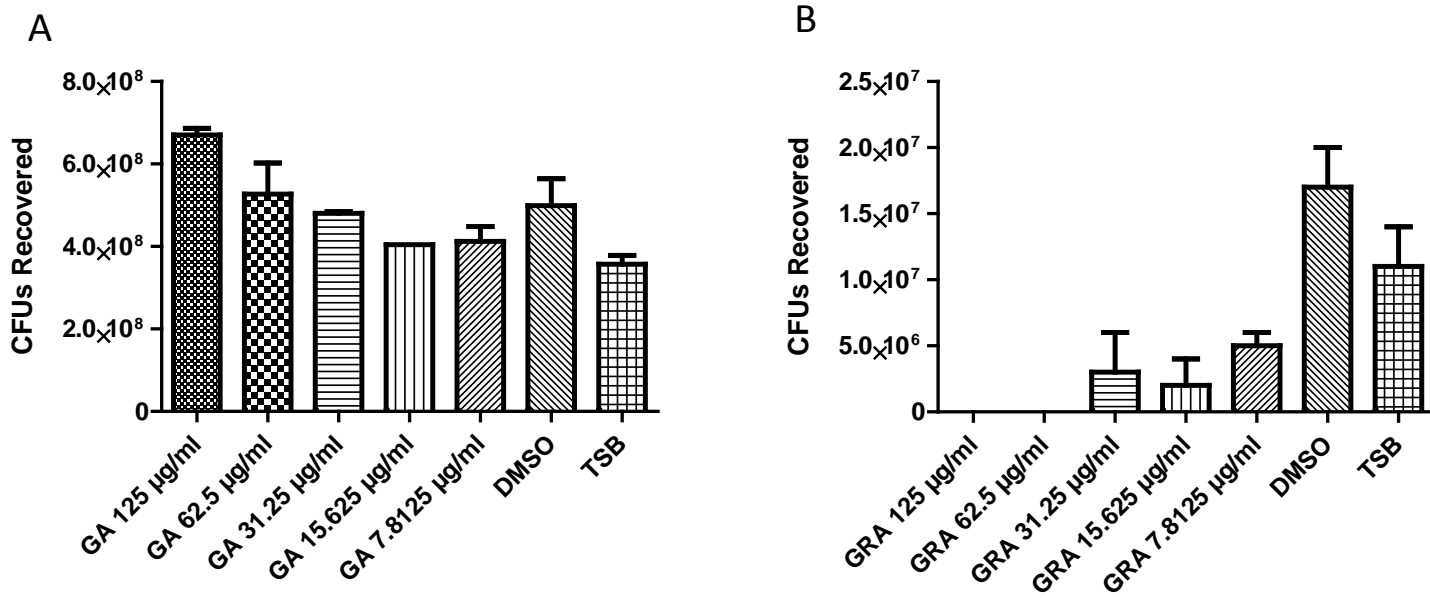


Figure 4. GRA has antimicrobial activity against MRSA. 1.05×10^8 CFUs of *S. aureus* (MRSA strain LAC) were grown to mid-exponential phase; washed and resuspended in TSB and incubated in media with varied concentrations of GA or GRA for 1 hour. CFUs were obtained by plating on TSA and enumerating colonies the following day. (A) Glycyrrhizin (GA). (B) 18-β Glycyrrhetic acid (GRA). Data was representative of three experiments.

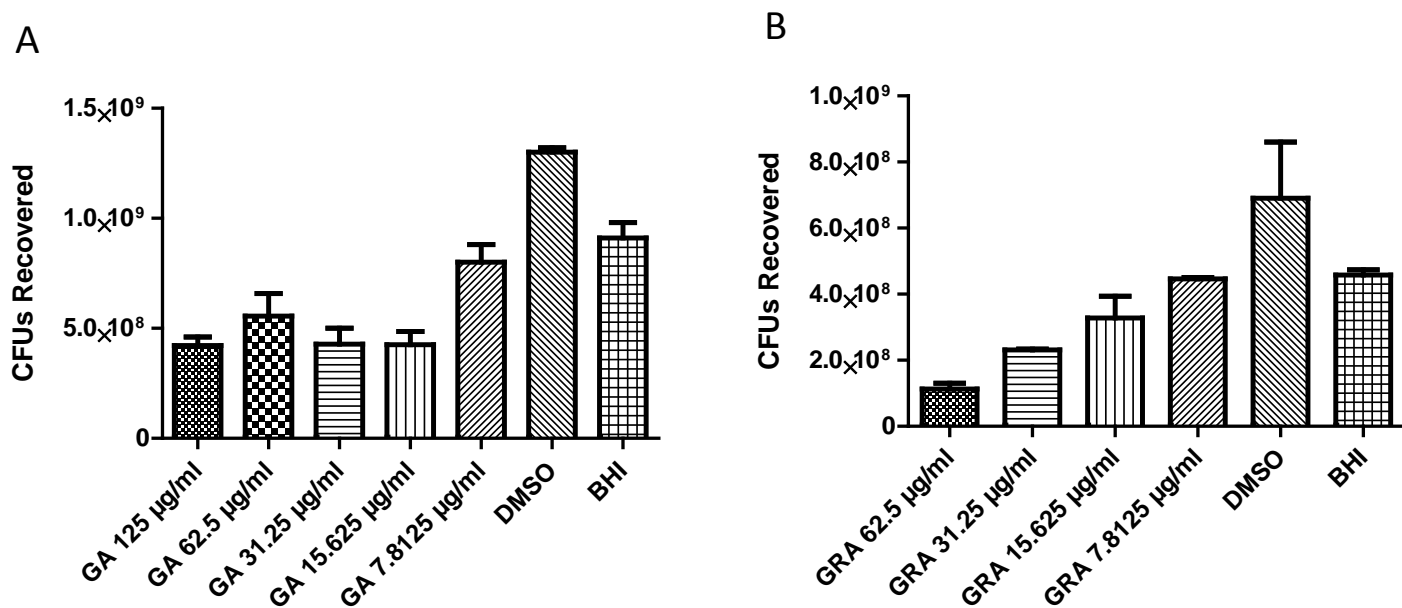


Figure 5. GRA has antimicrobial activity against *Streptococcus agalactiae*. *Streptococcus agalactiae* (2.07×10^8 CFUs) was grown to OD of 0.4; washed and resuspended in BHI and incubated in media with varied concentrations of GA or GRA for 1 hour. CFUs were obtained by plating on BHI-agar and enumerating colonies the following day. (A) Glycyrrhizin (GA). (B) 18-β Glycyrrhetic acid (GRA). Data was representative of three experiments.

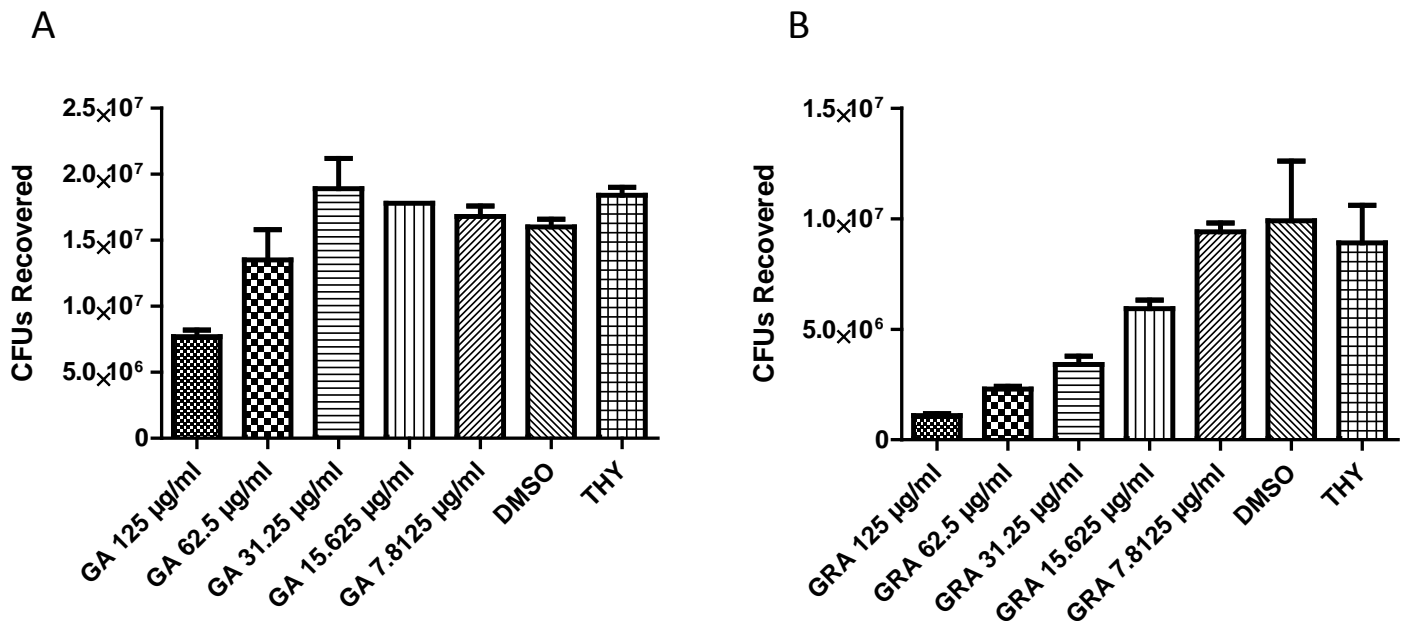


Figure 6. GRA has antimicrobial activity against *Streptococcus pyogenes*. *Streptococcus pyogenes* (7.00×10^6 CFUs) was grown to OD of 0.35; washed and resuspended in THY and incubated in media with varied concentrations of GA or GRA for 1 hour. CFUs were obtained by plating on THY agar and enumerating colonies the following day. (A) Glycyrrhizin (GA). (B) 18-β Glycyrrhetic acid (GRA). Data was representative of three experiments.

Discussion

Figures 1-3 demonstrated the expected sigmoidal curve associated with standard growth curves calculating CFUs and measuring OD600 at half-hour intervals. Based upon the growth curves, we determined OD₆₀₀ values of 1.5, 0.4, and 0.35 for *Staphylococcus aureus*, *Streptococcus agalactiae*, and *Streptococcus pyogenes* respectively represented logarithmic growth; bacteria were harvested at these values for the bactericidal assays. Although the values may not all be the exact midpoint value of the standard growth curves, all three values are representative of the exponential phase for bacteria growth and thus viable for interpretation. We repeated *Staphylococcus aureus* bactericidal assays and used these values as a comparison point to determine the varied effectiveness of both GA and GRA against *Streptococcal* species of bacteria. Each of the bactericidal assays shown are representative of three experiments. The *Staphylococcus* bactericidal assay matched with previous observations with demonstrated dose dependent bactericidal activity of GRA (1). Upon initial evaluation of the GRA activity against *Streptococcus agalactiae* and *pyogenes* from figures 5 and 6, the data points seem roughly similar in terms of dose-dependency to the data shown with *Staphylococcus aureus* from figure 4. However, the GRA was far more effective for *Staphylococcus aureus* than for either of the *Streptococci* bacteria. For example, there was no bactericidal recovery at 62.5 µg/mL in

Staphylococcus aureus exposed to GRA; yet, there was recovery in both *Streptococcus* species. This implies that *Streptococci* bacteria might employ better mechanisms or cellular structures that downgrade the effectiveness GRA antimicrobial activity and warrant further investigation. For GA comparison, there was not much difference between the *Staphylococcus* genus and the *Streptococcus* genus. In both cases, GA either had no effect or seemingly increased growth by a little. These data support the hypothesis that GA does not appear to have antimicrobial activity against Gram positive pathogens.

Due to the effectiveness of GRA in *in vitro* studies, future experiments entail an ointment or lotion to administer GRA to mouse models for *in vivo* studies. Once an effective salve is found for GRA administration, *in vivo* studies will provide a more accurate idea about the viability of GRA as an antibiotic alternative.

The results of the experiments confirmed our hypothesis that GRA would have bactericidal effects on *Streptococcus* species. However, GRA did not appear to be as bactericidal to *Streptococci* bacteria compared to its antimicrobial activity against *Staphylococcus aureus*. Further studies need to be done to determine the reason as to why GRA seems less effective for *Streptococci* bacteria and to determine the exact antimicrobial mechanisms of GRA. These additional studies will help answer important questions such as if there is a specific mechanism employed to circumvent the effectiveness of GRA and can bacteria gain resistance to GRA upon repeat exposure?

Materials and Methods

Bacteria Strains and Culture

Staphylococcus aureus

Staphylococcus aureus (MRSA strain LAC) cultures were grown in Tryptic Soy Broth (TSB) containing 5% glucose. Using a culture to flask volume ratio of 1:5, 20 mL media was inoculated with a frozen stock of bacteria and incubated at 37 C with shaking of 250 RPM overnight. A bacteria stock ($\sim 10^8$) was used for both the standard growth curve and the bactericidal assay.

Streptococcus agalactiae

Streptococcus agalactiae cultures were grown in Brain Heart Infusion (BHI) media. Using a 50 mL falcon tube (for the 1:5 culture to flask volume ratio), 10 mL of media was inoculated with a frozen stock of bacteria and incubated without shaking in 5% CO₂ incubator. A bacteria stock

($\sim 10^8$) was used for the both the standard growth curve and the bactericidal assay.

Streptococcus pyogenes

Streptococcus pyogenes cultures were grown in Todd-Hewitt broth (THY) with 2 grams or 6.25% of yeast extract. Using a 50 mL falcon tube (for the 1:5 culture to flask volume ratio), 10 mL of media was inoculated with a frozen stock of bacteria and incubated without shaking in 5% CO₂ incubator. A bacteria stock ($\sim 10^8$) was used for the both the standard growth curve; a bacteria stock ($\sim 10^5$) was used for the bactericidal assay.

Glycyrrhizin and 18-β Glycyrrhetic Acid

Stocks of GA (Fluka Analytical) and GRA (Aldrich) were suspended in 100% dimethyl sulphoxide (DMSO, Sigma). 25 µl aliquots were frozen in 25 mg/ml concentrations. Stocks were diluted according to specified concentrations as indicated by the experiment.

Bactericidal Assays

Staphylococcus aureus

LAC ($\sim 10^8$) was resuspended in TSB with decreasing increments of GA and GRA (diluted in a 1:1 mixture, using serial dilutions) in a 96-well microtiter plate. The plate was incubated at 37 C for 1 hour and then plated onto Tryptic soy agar (TSA). Colony forming units (CFUs) were counted the following day. Percent survival was calculated using this formula:

$$\frac{CFU \text{ at } 1 \text{ hr}}{CFU \text{ at } 0 \text{ hr}} * 100$$

Percent survival was not shown in results.

Streptococcus agalactiae

The bacteria ($\sim 10^8$) were resuspended in BHI with decreasing increments of GA and GRA (diluted in a 1:1 mixture) in a 96-well tissue culture plate. The plate was incubated at 37 C for 1 hour and then plated onto Brain Heart infusion agar. Colony forming units (CFUs) were counted the following day. Percent survival was calculated using this formula:

$$\frac{CFU \text{ at } 1 \text{ hr}}{CFU \text{ at } 0 \text{ hr}} * 100$$

Percent survival was not shown in results.

Streptococcus Pyogenes

The bacteria (~10⁵) were resuspended in THY with decreasing increments of GA and GRA (diluted in a 1:1 mixture) in a 96-well tissue culture plate. The plate was incubated at 37 C for 1 hour and then plated onto THY agar. Colony forming units (CFUs) were counted the following day. Percent survival was calculated using this formula:

$$\frac{CFU \text{ at } 1 \text{ hr}}{CFU \text{ in control at } 1 \text{ hr}} * 100$$

Percent survival was not shown in results.

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Indigenous Earth science knowledge inherent in Native language place names

Dominique David-Chavez (McNair Scholar)

Lisa Lone Fight & Dr. Wayne Stein (McNair Research Mentors)

Abstract

Exploring Native language place names reveals Indigenous science about the natural environment that may contribute to sustainable resource management and development in the coming generations. Based on centuries of observation, this knowledge has survived in the context of Elders' oral histories and Native language place names. In order to preserve and re-contextualize these valuable scientific resources, this study looks at GIS (Geographic Information Science) technology as a viable instrument for integrating Indigenous and Western science. Original Native names for the Gallatin Valley Headwaters Rivers will be overlaid with ecological and topographic data layers to demonstrate the relationships between Native language place names and Indigenous science knowledge. As community-based participatory research, this study will allow Elders and Indigenous science experts from communities familiar with this study area to define the context surrounding Native place names. In the future, GIS models like the one developed in this study may be utilized as tools for more culturally relevant science education, natural resource management, and sustainable development. Ultimately, this research will serve as a bridge between the knowledge of Indigenous Elders and the environmental challenges that will need to be addressed by future generations.

Keywords

GIS, Indigenous science, Native language, place names

Our place names, much like layers of rock bedding, are stratified over time. Like our geologic records, they too reveal knowledge regarding the history of Earth and cycles of change. Among Indigenous¹ peoples there is a pattern of place names revealing ecological and topographic features (Hunn, 1996; Kingston, 2009). Many of the Indigenous place names have been buried beneath historic colonial place names designated to honor explorers, the politicians who funded them, and the women they loved. Those Indigenous place names which remain have mostly been decontextualized through translation. What is the Indigenous Earth science

¹ 'Indigenous' and 'Native' are the primary terms chosen throughout this paper. The author intends these definitions to mean peoples of the land, whose way of life is intimately connected to a particular place in which they have a multi-generational history. Other terms are used with respect to the work of previous authors cited.

knowledge² of the Gallatin Valley headwaters rivers inherent in the local Native languages? This is the question that this research aims to explore.

This research is a small piece of a larger process; which is taking place in many nations around the globe currently; revealing diverse ways of knowing that have been historically suppressed or neglected. In the recently adopted United Nations Declaration on the Rights of Indigenous Peoples such issues are addressed on an international level (UN General Assembly, 2007). This document recognizes “that respect for indigenous knowledge, cultures and traditional practices contributes to sustainable and equitable development and proper management of the environment. . .” (p.2). Today, we find more Indigenous people entering the fields of research and science in an effort to include their own voices in these contemporary discussions.

Sustainability has been ever present in recent discussions regarding resource management, development, and climate change. As scientists traverse the universe for knowledge to sustain our species they are beginning to look to Indigenous peoples who have historically maintained their natural resource practices around this central principle. Soren C. Larsen and Jay T. Johnson look to Indigenous science as a means to challenge concepts of place. In their explorations they find that “Indigenous research not only transforms those involved but also points us toward a more inclusive and sustainable world community in the new millennium” (Johnson & Larsen, 2012, p. 11).

Whether officially acknowledged or not, Indigenous science has been utilized by contemporary voyagers when exploring and mapping new territory. In his research on maps of the Columbian encounter, J. Brian Harley revealed that “Indian geographies were incorporated into the fabric of European maps that would become standard images of America for much of the sixteenth and seventeenth centuries” (1992, p. 522). The following observation was written in an 1813 account on the travels of Captains Lewis & Clark:

“The Indians are totally unskilled in geography as well as all other sciences; and yet they draw on their birch bark very exact charts or maps of the countries they are acquainted with. The latitude and longitude is only wanting to make them tolerably complete.” (Fisher Esq., p. 52)

Today, 200 years after this was written, one has to wonder to what extent this sentiment has changed. This research would reason, as others have before (Cajete, 2000; Deloria, 1995), that Indigenous science is a science in its own right with much to contribute to contemporary research. Although integration of different ways of knowing comes with challenges and conflicts, which will later be described in this paper, this research will illustrate that such

² ‘Indigenous science knowledge,’ and ‘traditional ecological knowledge’ should be understood as knowledge about the natural world based on centuries of observation.

knowledge should be honored and included in scientific discussions for both its historic contributions, and the possibility of meeting some of our greatest challenges in sustaining our life preserving natural resources.

Undoing the legacy of 500 plus years of colonialism may take several generations. The process, as the author defines it, is a cycle of recognition, reconciliation, recontextualization, and renewal (figure 1). Through researching Indigenous place names we will exercise this process and model, and possibly apply this model to diverse ways of knowing in other academic fields.

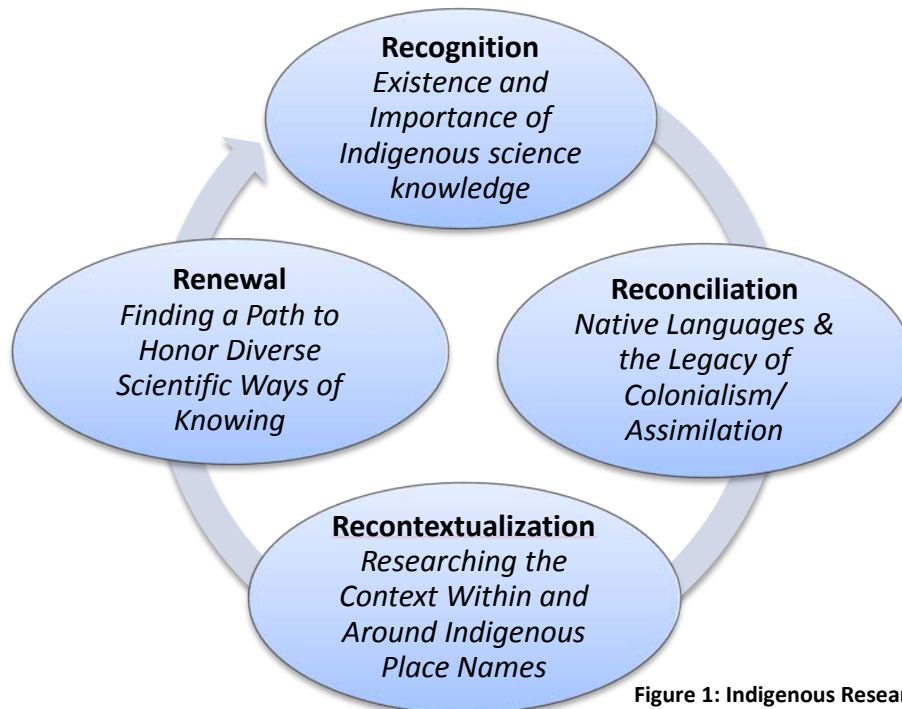


Figure 1: Indigenous Research Process
Based on Hopa Mountain Native Science
Fellows seminar led by Dr. Gregory Cajete

Recognition: *Existence and Importance of Indigenous science knowledge*

Native language place names and the scientific context surrounding them are encompassed in what has been called Indigenous science. In Gregory Cajete's book on the subject he defines it as such:

"Ultimately, science is storytelling for understanding of the natural world. Indigenous science is also a process for understanding, a way of coming to know rightful relationships to the natural world that yields life" (Cajete, 2000, p. 80).

Cajete goes on to describe that, even though Indigenous science is learned differently than Western science, the process has many parallels. He explains that "certain processes must

occur in a particular order, which in its way is similar to the precise ways that an experiment is executed within the Western scientific method” (Cajete, 2000, pp. 80-81). Modern descendants of Indigenous peoples are living evidence of the value and perseverance of Indigenous science. Through observation and experimentation their ancestors learned to survive and even flourish in a variety of environments. Their understanding about the environment produced extensive knowledge regarding agriculture and health that have influenced societies around the globe through introducing a variety of foods and medicines.

In 1993, when a mysterious virus broke out on the Navajo Reservation in northeastern Arizona Indigenous science knowledge helped to identify its source. Through generations of observation regarding weather changes and cycles, Navajo Elders recognized the connection between surplus moisture, pinion nut crops, and a rise in the rodent population. Through their oral tradition they recalled “that excess moisture and an abundance of pinion nuts had occurred three times in recent history: 1918, 1933, and 1993. . . that many Navajos died of sudden and powerful diseases during those times” (Trafzer, Sakiestewa, & Madrigal, 2006, p. 11).

Based on the case study above and others, the Tribal Environmental Protection Agency (EPA) of the Twenty-Nine Palms Band of Mission Indians has taken the initiative to include Indigenous science to improve its knowledge base and ability to provide quality environmental risk assessments. According to the Tribal EPA, Indigenous science:

“ . . . is not Native beliefs but tested ways of understanding the environment through years of observation, experimentation, and use. Cultural science is the first discipline of the Americas, having its roots thousands of years before the arrival of Western Europeans. Native Americans have preserved their scientific knowledge, a body of information known and kept by tribal elders. Over a lengthy period of time, Native peoples gained knowledge of their environment through the oral tradition and experimentation, which taught them to know which plants to eat, use for medicine, and mix with other natural elements to improve and develop their scientific cultures. A great deal of this knowledge is alive today in the minds of tribal experts who know traditional stories, songs, traditional oral narratives, practices, and the historical and cultural teachings of their own elders. Indians have handed down cultural science and many retain this knowledge today.” (Trafzer, Sakiestewa, & Madrigal, 2006, p. 10)

Contemporary articles and case studies are continually emerging documenting the applicability of Indigenous science knowledge for fields such as agriculture, soil science, water conservation, healthcare, and forestry. A cooperative publication between Nuffic’s Indigenous Knowledge Unit and UNESCO’s Management of Social Transformations (MOST) Programme highlighted 22 ‘Best Practices’ from around the world in the field of Indigenous knowledge (Nuffic;

UNESCO/MOST, 2002). In the Hewa community of Papua New Guinea, Western scientists partnered with Indigenous knowledge experts to study how human impacts have affected biodiversity. Hewa partners provided generations of Indigenous science knowledge regarding local birds and their Indigenous definitions regarding habitat and altitude preferences. In this methodology Indigenous science “substitutes accumulated traditional knowledge for years of research by western scientists” (p.123). This practice also demonstrated how even nations with few economic assets may utilize their rich knowledge resources and apply them to sustainable development programs. Recognizing such practices additionally adds value to this knowledge in professional forums and empowers Indigenous peoples to play a more active role in the future of their communities.

Before this partnership took place, all Hewa Indigenous knowledge was transmitted orally. For many Indigenous peoples their science knowledge remains in oral traditions, stories, bundles and otherwise elusive to the paradigms of Western science. Many Indigenous communities are recognizing the need to include this knowledge in environmental assessments, resource management, and development plans. They are challenged to find a way to translate and record this knowledge (as well as protect it) so that it will not be neglected in long-term planning of their communities. In another best practice highlighted by Nuffic and UNESCO/MOST, the Inuit and Cree communities of the Hudson Bay bioregions were addressing this challenge. Indigenous participants in this study set a goal “to put their ancestral knowledge of the environment into writing so that it is appropriately transmitted and incorporated into environmental assessments and policies and communicated effectively to scientists, the interested public, and the youth of the participating communities” (pp.221-222). In this study, Indigenous knowledge was recorded in multiple layers and then overlaid in regional maps and a GIS database.

Another study using geospatial science in partnership with Indigenous science is presented in Bethel, Brien, Danielson, Laska, Troutman, Boshart, Giardino, and Phillips article on wetland restoration planning in coastal Louisiana (2011). To address the needs of an area experiencing dramatic environmental degradation of marsh habitat, scientists team up with local Indigenous residents who “are intricately tied to the surrounding ecosystem and have a long history of adaptation to the challenges associated with persistent change within the ecosystem due to both natural and anthropogenic factors” (p.557). In their methodology they found Indigenous science data sets to be helpful in guiding their investigation as well as better meeting the restoration needs of local residents than by using Western science alone. Collaborative field work methods provided a format for synthesizing community resident’s traditional ecological knowledge observations regarding environmental changes. An exchange of knowledge took place over the course of the study in which physical scientists were educated on traditional ecological knowledge and Grand Bayou residents introduced to geospatial technology. The

product of this study aided in coastal wetlands management decisions by providing Gulf Coast resource managers with tools for assessing ecological change and patterns of fragmentation.

Maintaining a balance with the resources provided to us by nature has been the means to survival of Indigenous peoples' way of life since time immemorial. Today we call this practice 'resource management' and Indigenous science finds its most obvious application here. The Twenty-Nine Palms Band of Mission Indians Tribal EPA observes that Indigenous science:

“... is reflected in traditional land management techniques employed by Indians for thousands of years to tend wild lands, resources, plants and animals. Indian people burned to regenerate seeds and plants, sowed wild seeds, pruned plants, weeded, burned, irrigated, and used other techniques to care for plants, protect habitats, and increase the yield of useable resources. Native American interaction with the environment proved beneficial to plants, which in turn helped humans and animals. Cultural scientists among the tribes have in-depth traditional ecological knowledge, and this knowledge can inform modern tribal EPA about the entire ecological system. . . They often know when the ecological system is out of balance and environmental components are out of place. Working closely with Tribal EPA, tribal scientists can be of utmost assistance in identifying problems.”(p.12)

The Tribal EPA found that the Elders of the Chemehuevis of Twenty-Nine Palms Tribe, the Chemehuevi Tribe, the Colorado River Indian Tribes, and Fort Mojave Indian Tribes “have in-depth cultural knowledge of land use, trails, desert and mountain springs, plants, animals, medicines, and environmental change over time” (p. 19). The contribution of Indigenous scientific knowledge that took generations to acquire is truly a gift to the field and should not be neglected lest it be forgotten with the passing of these Elders.

Indigenous science has emerged within academia over the past decades to challenge and re-evaluate existing paradigms of producing knowledge and research (Johnson & Larsen, 2012). Referring back to our 19th century quote, the way we define “geography,” for example, may lead to the exclusion of diverse ways of knowing. Are lines of latitude and longitude the ultimate determinants? Harleys' studies of Indigenous cartographies recognized the following:

“... in 1492 mapping was by no means alien to the cultures of either Middle or North America. Since such indigenous forms of mapping had developed in situ and away from any possible influence from the Old World, we may need to revise our ideas about the levels of geographical awareness and representation in American Indian cultures as a whole” (p. 526)

We find our pre-Columbian maps in the collections of art historians and museums as they “did not fit the notion of a “scientific” map as understood by cartographers and geographers trained in Western traditions” (Harley, 1992, p. 525). Jennifer Adams found one such map on a visit to the Museum of Natural History. As she observed an Aboriginal map depicting how to travel between waterholes, she was “struck by the notion that this map would not only point out geographical land-marks but also depict a way of thinking about traveling between these features” (2010, p. 456). She wondered “what these complex understandings of the universe could offer science and science education.” Harley (1992) interpreted retention of Native place names in early cartography, and those recalled in Columbus’s written correspondences, as both evidence of cultural exchange between Indigenous peoples and Europeans, and a means of appropriation. It is fascinating to think what the science fields would look like today, had this cultural exchange been one of mutual respect and appreciation.

Both a challenge and a gift, Indigenous science comes from ways of knowing that may be very different from those in Western science. A person’s place and responsibilities within a much greater community than those divided by artificial political borders, a belief in the power and importance of intuition and visioning in one’s work, for examples may exclude some from exploring these fields. These differences however, may just be the ingredients necessary to spark innovation and guidance in knowing what to look at to solve some of our greatest challenges.

Reconciliation: Native Languages & the Legacy of Colonialism/Assimilation

“By knitting together the seams of Pangaea, Columbus set off an ecological explosion of a magnitude unseen since the Ice Ages. Some species were shocked into decline (most prominent among them Homo sapiens, which in the century and a half after Columbus lost a fifth of its number, mainly to disease).”

(Mann, 2011, p. 361)

Although the precise number of population loss is contested, it is generally agreed that European diseases took a devastating toll on Indigenous peoples of the Americas. Studies on place name density may help to reveal the extent of Indigenous knowledge lost as a result of disease, settlement, and land appropriation. In Hunn’s study an estimated 60 percent of Sahaptin place name knowledge had been lost (1996). The changes wrought by such a huge and sudden decline in populations have led to a great deal of misinterpretation and confusion regarding the history of the Indigenous nations of this country. The myth of “pristine wilderness” and land “untouched by man” prevails throughout early explorations as entire villages were nearly erased by the diseases that preceded their colonial sources. The loss to the

field of science is immeasurable. In those instances where exchanges did take place, in examples of art, agriculture, and even political diplomacy, innovation abounded. Charles Mann, in his writings about the Americas before Columbus, challenges us to “envision this kind of fertile back-and-forth happening in a hundred ways with a hundred cultures—the gifts from four centuries of intellectual exchange. . . along with the unparalleled loss of life, that is what vanished when smallpox came ashore” (Mann, 2011, pp. 140-141).

Even though disease played a major role in disempowering Native languages, and in turn Indigenous science inherent in those languages, it was the political and social ambitions of a new society that inflicted what may be the most lasting damage to Native ways of knowing. In 1868 Native languages in the U.S. were commissioned to be replaced with English (Crawford, 1995). The boarding schools institutionalized federal policies of assimilation and affected values of Native peoples for generations to come. As Crawford describes, Native American “parents see advantages to raising their children mostly or entirely in English, the language of social and economic mobility” (p.28). Generations of children stolen away from their families and Indigenous knowledge bases were taught to disregard both their traditional values and their Indigenous science. For those in whom the seeds of assimilation were planted, many in turn passed these values down to their own children and grandchildren. Cycles of neglect, shame, and ignorance regarding Indigenous knowledge perpetuated with each generation.

In the 2010 U.S. Census there was a 50% drop of Native language speakers between the age groups of 5-17 yrs. and ages 65 and over for those identifying as American Indian or Alaska Native alone. For those who identified as a combination of American Indian or Alaska Native and another racial background there was not a drop in language speakers, however among all age groups of this category there were less than 1% who spoke a Native North American language. The largest percentage of Native North American language speakers reside in an American Indian or Alaska Native area (excluding Hawai’ian homelands). Within the U.S. and Puerto Rico this population comprises only 5.4% of American Indian and Alaska Natives (U.S. Census Bureau, 2011, p. 2).

Colonial treatment of Native languages is reflected in the renaming and de-contextualization of Indigenous place names. In describing maps of the New World, Harley proclaims “each name on the map is a written record of an act of territorial consecration” (1992, p. 530). He goes on to assert that “similar acts of toponymic possession convey the same sense of appropriation legitimized by religion.” Native ways of knowing are intricately tied to the land. Indigenous languages serve as the means of communicating knowledge about the land, and the place names in particular convey that which is meaningful and important to the people who designate them. In defense of the immense value of linguistic diversity, James Crawford explains that “from a scientific standpoint, the destructions of data is always regrettable . . .

loss of a language represents the loss of a rare window on the human mind . . . a unique tool for analyzing and synthesizing the world. . ." (1995, p. 33).

Recontextualization: *Researching the Context Within and Around Indigenous Place Names*

Community-based participatory research (CBPR) as defined by the National Congress of American Indians (NCAI) Research Center, provides a framework for building long-term rapport and strong partnerships within the research community by including community needs and priorities throughout the research process (Sahota, 2010). CBPR also allows an opportunity to maintain a high level of context in the research process as well as in the product of scientific research. The issue of recontextualizing Native language placenames is closely aligned with educational research priorities identified by tribal leaders in the NCAI's Comprehensive Tribally-Driven Research Agenda draft (NCAI Policy Research Center, 2006). In this draft for issue-specific research topics Native language is addressed in terms of best practices for implementation of a culturally-relevant educational environment and identifying barriers to this process.

The primary purpose of this research is to explore the Indigenous science knowledge inherent in Native place names of the Gallatin Valley Headwaters Rivers. Patterns between these place names and Western Earth science knowledge will be demonstrated in a multidimensional framework utilizing ArcGIS 10.2 mapping software. Qualitative and quantitative data will be represented in layers to provide a map that demonstrates the integrative qualities between Indigenous place names within their Indigenous context and Earth science knowledge. Depending on the needs and access preferences of the community participants, this map will be eventually be exported into an environment where it can be accessed for educational purposes, such as Google Earth.

Including community members in the research steps for addressing this issue is of fundamental importance to this project and has been explicitly outlined in the methodology for conducting this research. Initial partners for this research study will be identified through word-of-mouth in local Native communities and referrals from Tribal College contacts. Once partners have been identified, interviews will be conducted with Elders and Indigenous science experts to identify the context surrounding the Native place names. Interviews will be conducted according to CBPR guidelines outlined by the National Congress of American Indians.

Indigenous science knowledge identified by interview participants will be then be used to choose related GIS layers. GIS layers will be downloaded from relevant scientific databases such as the Natural Resource Information System (NRIS), U.S. Environmental Protection Agency (EPA), and the National Atlas. A map containing both Indigenous and Western science layers

will be reviewed by participants for accuracy and relevance. Forums will be identified by participants for sharing this research (e.g. educational/community centers) and implications for future research will be discussed.

Place names reflect what is important to the people who inhabit and use them. For Indigenous peoples, familiarity with minerals, plants, water, and other ecological resources was imperative for survival. Deanna Paniataaq Kingston's study on Inupiaq place names of King Island, Alaska recognized the importance of documenting "King Island place names . . . as well as to the environmental knowledge held in the place names" (2009, p. 8). Data from the study is planned to be analyzed for the purpose of understanding how the Indigenous population of King Island managed their natural resources. Further research of the Seward Peninsula/Bering Strait region of Alaska found that "In general, places are named for what the place is, what it looks like, what different plant or animal species might be found there, a place's relationship to other places in the landscape or what activities may happen in that place" (Kingston, 2009, p. 20). For the Canyon de Chelly Navajo of Arizona, "Rocks of various kinds constitute the largest category of named natural features, with canyons a close second; plant and animal referents are quite common." (Jett, 1997, p. 481) "In contrast to English place names, "Only about 10% of the names were determined to relate to specific human-historical or mythological occurrences or to repeated human activities" (p. 489). In his study on Sahaptin Native language place names Eugene Hunn found the highest percentages of place names to be ecologically and topographically based (1996). Hunn found this to contrast with the practice of English place-names based on people. In comparison with English place-names, Hunn discovered both Sahaptin and Dena'ina place names to contain a considerable (~ 18.8%) amount more place-names referring to plants or animals present at the sites. In his research Hunn also found that "Statistical analysis of place-name distributions provides clear evidence of culturally distinctive land-use strategies and settlement patterns" (1996, p. 22). It is clear to see how this knowledge could provide useful for both resource management and studies regarding climate change.

For an illustration in English place naming we look to J.V. Brower's geographic explorations up the Missouri River to the crest of the Rocky Mountains on Montana's southern border. Here we find an example in the practice of designating place names in which "for the purpose of a convenient geographical reference upon the chart, names for several localities have been carefully chosen, with an attempt to appropriately designate characteristic features or historic occurrences. . ." (1896, p. 390). One place name out of the twenty-one names provided evokes explicit ecological reference (*Swan Lake*, after a nesting place). Only two additional names possess any reference of natural occurrences: *Red Rock Lakes* (after a red butte) and *Alaska Basin* ("Name probably suggested by deep snows"). All of the additional names are either those of people or a relatively recent human event/activity. On the maps presented with this article, 'Prehistoric Village Sites' are marked as well as reference to buffalo trails and wallows. In

Brower's account he states that "We found no signs of man's presence before us, except an old Indian trail and the site of an old Indian camp near Lillian Lake, where trees had been hacked down in characteristic aboriginal fashion." (1896, p. 388) The lake referenced in this quote was noted to be named after the first "lady tourist" (p. 390).

What these studies demonstrate is that Indigenous names often hold very different meaning (and inherent Indigenous knowledge) that more recent place names may not convey. When place names were put to paper they were often those of post-Columbian cultures. Some Indigenous place names remain in the U.S. Board on Geographic Names; however they have most often been stripped of their traditional context. Stephen C. Jett, in his research on Navajo place names warns that "It is easy to overlook what place-names may reveal" and that "It is also possible to be overly optimistic as to how much may be learned from place-names; but certain conclusions as to Navajo perception of their habitat can be made, especially when one has wide knowledge of other aspects of Navajo culture and history (and without that wider knowledge and without the reasons that specific places were given their names, one would in some cases come to incorrect conclusions" (1997, p. 491). In order to study Indigenous place names, researchers may have to contend with cartographic representations vastly different from their own. In Lesley J. F. Green and David R. Green's (2009) research with Indigenous Palikur speakers of the territory of Arukwa in Amapá, Brazil "multiple temporalities, including the autobiographical, ecological, astronomical, genealogical, and historical" exist in the place name narratives of the people (p.163). Their article argues that "formal technology of cartography . . . is inadequate to the task of understanding the practice of listing place-names insofar as it separates body, temporality, and sky from place". The Twenty-Nine Palms Band of Mission Indians' Tribal EPA recognizes the validity of stories as they hold meaning and significance and for their importance in conveying culturally-relevant scientific knowledge (Trafzer, Sakiestewa, & Madrigal, 2006).

Due to its use as a trade and travel route, as well as the wealth of natural resources and rich riparian habitat associated with it, the Missouri Headwaters Rivers were travelled by many regional tribes including the Shoshone, Nez Perce, Arikara, Mandan, Hidatsa, Blackfeet, and Crow. According to the Indian Education for All unit on the Missouri Headwaters State Park "For over 12,000 years the Headwaters region was a common meeting point for tribes, as the river . . . provided many opportunities to gather resources and exchange goods" (Montana OPI, 2010, p. 2). This educational material also references the rivers' proximity to the Madison Buffalo Jump and to stone quarries necessary for tool-making and trade. Parts of the headwaters of the Missouri inhabit the territory of the Apsáalooke (Crow) tribe. Here is an example of their relationship with this area in terms of Apsáalooke language place names and the context that surround them.

The following are official English names, as well as Apsáalooke names and their English literal translations (Little Big Horn College) of the three headwaters rivers:

English Name	Apsáalooke Name	English Literal Translation
Gallatin River	<i>Baáchuuaashe</i>	“Berry River”
Jefferson River	<i>lichíilaashe</i>	“Horse (previously Elk) River”
Madison River	<i>Aashalatatche</i>	“Where The River Is Straight”

[include a table with names & literal translations from other tribes mentioned above here]

Indigenous science will be explored as it relates to these three rivers, their Native language place names, and the stories/context surrounding them. Both Indigenous science expertise and literary resources will be included in this study.

[analysis to be included here]

Renewal: *Finding a Path to Honor Diverse Scientific Ways of Knowing*

In our more recent generations a new path is being forged both at the federal and grassroots level to allow Indigenous science knowledge to continue to be passed on to future generations. Some regions have provided legislative support for Native languages. For example, Alaska’s 1982 Senate Bill No. 727 instructing the State Geographic Board to use Native Alaskan place names for what have been otherwise unnamed features. Very few of these Indigenous place names have actually been made official though (State of Alaska, 2011). In 1990 Congress passed the Native American Languages Acts to “preserve, protect, and promote the rights and freedom of Native Americans to use, practice, and develop Native American languages” (U.S. Congress, 1990). In 2006 the Esther Martinez Native American Languages Preservation Act provided further support to language revitalization by providing federal grant funding for language immersion programs (U.S. Congress, 2006).

The United Nations Declaration on the Rights of Indigenous Peoples also addressed language revitalization efforts, including “the right [for Indigenous peoples] to . . . designate and retain their own names for communities, places and persons” (Article 13). This declaration also emphasized rights regarding providing culturally relevant education (Article 14) and “the right to maintain, control, protect and develop . . . traditional knowledge . . . as well as the manifestations of their sciences, technologies and cultures. . .” (Article 31).

Geospatial science technology shows great promise of providing the forum to sustain Indigenous science knowledge for our future generations. In regards to the challenges of

integrating qualitative traditional knowledge with quantitative data, innovative researchers are forging a path for others to navigate. The risks of pursuing this form of research bear little weight to the peril of losing such vast stores of Indigenous Earth science knowledge.

In recognition of this risk, the Maori community of Aotearoa (New Zealand) has utilized GIS as a means of recording aspects of Indigenous knowledge and values that they deem to be important for future generations. Garth Harmsworth (1998) recognized that within this framework “such tools complement the indigenous knowledge systems traditionally used to store and transfer knowledge and information . . .” (p.1). GIS is used in in these studies to provide multidimensional layers for sites in which particular layers can be protected and limited to individuals or groups within the tribal community. Bethel (et.al.) deliver a great gift to the scientific community by providing coding methods and mapping products that “provide a repeatable solution for incorporating the wealth of local knowledge with scientific data sets, including the historical and projected land-loss maps derived with geospatial technologies that are currently used by restoration managers and scientists” (2011, p. 568). In this same article benefits for integrating diverse ways of knowing in a GIS framework are recognized to include: “incorporating inputs and policies at various levels of spatial aggregation; promoting spatial and temporal thinking about issues and concerns; and creating opportunities for learning and sharing of responsibilities.” (p. 557).

Cultural diversity and diversity of scientific knowledge has often been compared with the loss of biodiversity (Maffi, 2005; Crawford, 1995; Nabhan, Pynes, & Joe, 2002). How can we know how the extinction of a species, a language, a story, will affect our lives in the future? Without a bridge to carry this knowledge from one generation to the next we face a huge loss in diversity of knowledge. If we neglect to honor our Indigenous knowledge our Elders will carry it with them in their passing and it may takes generations to find the paths of scientific experimentation and observation that led them there. As we see in the studies above, the path to renewal of Indigenous Earth science knowledge has been shown to us. It is up to scientists and researchers to continue this process of Recognition, Reconciliation, Recontextualization, and Renewal, for the sake of generations to come and the innovative spark that lingers in the reaches of scientific exploration.

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Unexpected Uses of Instructor Feedback on Writing

Angie R. Ford

Instructor feedback is a text apart from the student work it responds to, but also part of a larger Text comprised of instructor/student interaction; and it should be analyzed as such. But little scholarship on responding to writing seems to accept this perspective. Most research on response, as Louise Wetherbee Phelps wrote in 2000, has based the majority of its questions on the assumption that instructor feedback is defined only as the commentary that teachers do on their students' papers. Instructors do seem to suppose that students only use feedback to revise their writing. In contrast, the research this paper reports on demonstrates how students define feedback more holistically, and include every channel of communication with the instructor as part of that feedback. They are using instructors' written response on their paper for something other than just revising their writing; they're testing the consistency and genuineness of instructors' typical invitations for students to express themselves, to construct new knowledge, or sometimes even to learn alongside the instructor, collaboratively.

In this paper, I describe what "the instructor's invitation to collaborative learning" means, pedagogical experiences that give rise to the term, and the role of students' holistic use of feedback to that pedagogy. I then discuss research I conducted that showed how students' conception of feedback is more dynamic than research to date has shown, and conclude by discussing practical applications of my observations, with examples of feedback that undermine and reinforce the instructor's invitation to collaboration.

Describing an Invitational Pedagogy

What is an invitational pedagogy? Just as an inviting home is a safe place where people can be themselves, a comfortable place where they desire to return, so an invitational pedagogy is one that focuses on creating a learning environment that is conducive to exploration. An invitational pedagogy eliminates much of the sense of stage, scripts, and narrowly defined roles, where with every interaction, the student is attempting to say and do the right thing for a scrutinizing instructor standing off in the dark shadows; it envisions learning as more of a journeying together. While it seems like some writing instructors keep their playbook a secret from even their own team, an invitational pedagogy opens the playbook and gathers everyone in class around the bench to discuss it. An invitational pedagogy is one where, rather than the guide going on ahead and the tour group unquestioningly following, the guide steps aside on the path to make room for the student to walk alongside. In this way, the student isn't told what exact steps to take, but rather gets to see why an expert in the field takes the steps that he does. An invitational pedagogy is one where the students are asked to come get their hands dirty in the real bread-baking happening in the kitchen, rather than being sent to a kiddie table with some PlayDoh to pretend.

One example of a pedagogy that's invitational by nature is Writing-About-Writing (WAW). WAW is First Year Composition (FYC) reimagined to leave behind the notion that there is one fundamentally correct way to write, and instead—with an eye towards effective learning transfer—focuses on awareness of situation; it claims that good writing is writing that effectively conveys the author's meaning to their audience, and that the means to accomplish that goal differ by audience, author, and message. Doug Downs and Elizabeth Wardle offer their conception of “teaching about writing” in FYC, emphasizing the exploratory nature of reading and writing:

“How does writing work? How do people use writing? What are problems related to writing and reading and how can they be solved? Students read writing research, conduct reading and writing auto-ethnographies, identifying writing-related problems, and conduct their own primary research, which they report both orally and in writing” (558). It follows then, that response within an invitational pedagogy would best work to further the pedagogy’s goals. For example, when responding to student writing, it isn’t simply that a WAW instructor knows how to take a directive statement and phrase it in an indirect way to simulate students’ being in charge of their own writing (as has been the practice of some approaches to response). WAW is invitational because its basic premises require student involvement on a level of collaboration—students are encouraged to consciously work alongside instructors to build their own knowledge. These premises that establish an instructor’s actual need for the student’s input in order to teach the student well are what differentiate between pedagogies that go for the same effect without genuine belief in the necessity of student collaboration—with each other and with the instructor. These premises ought to be evident within the instructor’s written feedback, as well: Genuine need of student collaboration for the purpose of building knowledge eliminates the patronizing indirectness that students all too often see through. The basis of the instructor’s need for genuine student contribution is the belief that knowledge is epistemic and that knowledge about writing is constructed, that is, it must be built by a series of interactions—never by one knowledge-giver delivering a neat package to a knowledge-receiver. The belief in collaboratively constructed knowledge says, “I can’t tell you how you’re supposed to write something when I don’t know what it is you’re trying to say.” There must be a back and forth, a give and take, a building of knowledge through collaborative experience. An invitational pedagogy seeks, more than anything, to construct an environment that is conducive to students feeling safe enough to bring

their own ideas, in their own words, to the table. Instructors might listen more than talk, but they listen in an interactive way: seeking to hear that grain of meaning beneath the student's meandering explanation, and, out of genuine interest, draw it out. Where some instructors would be impatient with students who don't seem to be getting to their point fast enough or are marginally off-topic, an invitational pedagogy says, "That's interesting; can you say more about it?" Moments of interaction like these go a long way to offer students a place where they can feel at home enough in the atmosphere of the learning environment to explore new ideas—here they can kick off their shoes and dip a toe in the river that previously belonged only to the instructor: the river of the knowledge of the field (Haswell, Haswell, and Blalock).

WAW is invitational in other ways too. The way it approaches class readings has a profound effect on students. WAW trusts its students with the primary texts of the field—writings for which they are not the intended audience. And overwhelm inevitably sets in. Students are concerned that they can't understand the whole text, so they are going to fail. But instructors don't ask for "the correct" reading. They ask "what do *you* see here? Write me a couple pages in response—what do *you* think is interesting?" And later, "Who do you think the intended audience was? Why?" Such discussions show some students that they read rhetorically without yet knowing the term. Reading responses are not graded for correctness, but credited for doing the reading and the thinking. This kind of being thrown into the deep end of the reading pool necessitates other aspects that play heavily into the invitational nature of WAW. One of them, as has already been mentioned, is in-class discussion. How can mere freshmen talk about texts introducing theory that even graduate students struggle with? They need to know that at this point in their exploration, there is no wrong answer; learning is something a class does together as it hashes out the confusion, interest in, or dislike of the reading. The kinds of discussions

produced by such dense reading assignments effectively further the pedagogy's goal of building knowledge through interaction: difficult questions will be raised, and from many angles.

Instructors might balk at this idea, for fear of not knowing all of the answers to these questions—and yet that very lack of knowledge on the instructor's part reinforces the invitation to collaborative learning: instructors aren't merely *playing* like they're learning from their students, they actually *are* learning from them. These interactional dynamics help students believe that their voice is indeed important in the class and to their instructor, and that they actually do bring something to the class that would be missing without their participation. They are rhetors, as well as audience-members. Of course, the price for assigning such dense texts to students is that they will assuredly read “wrong.” There is no way around it: First Year Composition students aren't going to read academic texts “correctly” all the time—or even much of the time. However, students report that being trusted with making their own meaning from the professional texts of the field and having a chance to discuss it with an expert in that field goes a long way in helping them feel like insiders and collaborators whose ideas are important, rather than placated students doing only what they're told.

The Impact of Feedback in Invitational Pedagogies

David Russell uses cultural-historical activity theory to study communities of people carrying out tasks or activities, each using tools to accomplish their goals (“Activity Theory,” “Writing”). Just as a shovel is used to move dirt or a bat to strike a ball and put an entire game in motion, so writing is a tool meant to accomplish a purpose. (And yet the metaphor only goes so far, for as the writing is the tool to accomplish, so the writing is the thing accomplished by tools of process: writing, while it is a tool, will never be *merely* a tool.) So innate is this principle of

constructing text based upon its intended use, that it exists within teaching actions, in many cases, invisibly. For example, during the brief time it has been studied, as analyzed by Robert Connors and Andrea Lunsford, instructor response on student texts has itself undergone a shift in purpose. Once, “response” was defined as placing a grade on an essay—its purpose to inform the student of their percentage of correctness. Later, “response” became merely the marking of errors within the paper by ruthless red pen—the purpose ostensibly to teach the student (not merely give them a grade), and justify the grade stamped at the top. The process movement of the 70’s shifted the role of the instructor—and with it the purpose of their feedback to students. It became possible to imagine a student having something to say that might interest the instructor, and thus the teacher could be conceived of as an audience. The purpose of feedback on student writing became to reflect the audience’s experience of reading the student text, showing the student how well they did at getting their message across to their audience (201).

Russell’s use of activity theory suggests that the way a text is constructed determines, in large part, what it is useful for. For proof, simply take a handwritten love letter from a couple separated by WWII and write it in the style of a memo from the CEO of an affluent company. Then handwrite the actual memo from the CEO and send it to your significant other to engender feelings of closeness. These are laughable examples because these texts are so obviously constructed for a use other than the one they are put to—how could anyone confuse them? It seems like it should be obvious to the texts’ audience that the writing was not intended for the use its form and delivery suggest. The same thing often happens, though, when students encounter baffling instructor comments on their draft—comments the instructors thought were clear, or they wouldn’t have written them. Every day as I tutor in a writing center, I see several students who bring in the same assignment from the same instructor and each student has a

different interpretation of what the assignment is—even with the assignment sheet in hand. Often, students will bring in drafts that have already been through a phase where the instructor commented on them and conferenced with the student regarding the paper. Tutors expect this instructor commentary on the student draft to be helpful, so that we can better know what the instructor expects from the student, not merely in this paper, but as representative of where the student is in their process of learning for the class. But often the feedback makes no sense to tutors; tutors turn to the student for the context, since they were there for the class and the conference—and students often shrug. “I don’t know what that means...I think...maybe...well no, because she said this other thing in class...” If we ask the instructors, however, they knew what their response to the student’s writing was meant to do, and it was very much meant to be put to a specific use: to show the student where their paper could be stronger, or clearer, or where an idea is fantastic but needs supportive evidence.

Another disjunct between student and instructor expectations for use of feedback is that instructors seem to understand their responses on student drafts as merely tools for students to use to strengthen their paper and their writing ability. But students use them for far more than this: to determine what their instructor will let them do. How much rein do they have to work with? If their instructor has claimed to give them freedom in the paper, how much does the student actually trust that invitation to explore? Or does this invitation simply stir up panic about what the instructor really expects? A striking number of students who come to the writing center report a profound confusion about what is expected of them based on how the instructor comes across to them. Usually this is due to conflicting messages being sent over the various channels of communication that instructors and students employ, such as in-class discussion, emails, assignment sheets, face to face conferring, and written feedback. During class discussion, the

instructor encourages open exploration of ideas and is easy going: the space is one conducive to learning. But then, either in the instructor's comments on student writing, or in the writing of an assignment, the instructor will show a severity the students can't reconcile. The often-heard phrase from the student is something like, "I think she'll be fine with what I wrote, she's pretty easy...but, well, I don't know, she also said she wouldn't bother to read it if it had more than five grammar errors in it..." The important point here is that, due to conflicting inputs, students cannot use the feedback as it was intended to be used: to improve their paper or their writing abilities. They do, however, use such feedback to decide what is *not* allowed by their instructor. Returning to the initial metaphor of communication being used for a purpose it was not written to accomplish, a memo outlining stricter policies on enforcing 10-minute breaks may work well to keep employees busy, but for the reader who expected it to be a love letter from a deployed soldier, the effect is hardly profitable. Instructors can create the best assignments, geared to invite a student to explore an unknown world of writing, but if, in the other channels of communication, the instructor focuses on issues of correctness, students are often frozen. They lose faith in the integrity of the instructor's call to learn together. Instructor feedback is no longer being used as it was intended by the instructor; it is being used to decide the instructor's true values and the result is establishing mistrust of the instructor. Just as the envelope addressed in the familiar hand of a lover promised to bring easy interaction, yet brought confusion as to the intent of the author, so the instructor has extended in one hand the offer to be a co-explorer, and in the other, grips a whip to punish missteps off the correct path. Somehow the whip is invisible to the instructor, while the student uses the whip to dictate their "exploration."

If the stakes are high for leaving the whip invisible to instructors in the classroom, then they are even higher when conducting research: studies on response have not gotten at this

discrepancy between the way instructors intend feedback to be used and the way students are in fact using it. Research scholarship most likely will not identify this gap between intention and use unless student perspective is the place research begins. Research has begun to gain student perspective, but even the studies that ask students for their perspective on instructor response are still, in a way, instructor-focused: Research questions are those instructors would think to ask in order to better ascertain how to formulate their feedback to facilitate students' learning and writing revision. "How helpful was teacher A's responses on your draft vs. teacher Z's responses?" is one question response research has already asked. "What does an instructor's written response tell you about your teacher and what kind of input they value from you?" is another question entirely, that gets at other issues embedded in response and its uses. A major discrepancy exists between what response scholarship regards as best practices and what actually gets practiced in classrooms, and the gap is conspicuously long-standing. Could it be that we are asking the wrong questions? Research has been calling for student perspective for years, but to access this perspective, scholars need to ask different questions: What messages does an instructor send, over each channel of communication? What kinds of interactions do these messages suggest the instructor values from the student? What action does the student take in response? For response to be studied in a satisfying way, it must be studied as a continuing loop, realizing that, as Louise Wetherbee Phelps noted, instructor feedback is born of instructors' silent responses while reading student writing—writing that was penned in response to signals instructors might not even realize they are sending out.

Response Through Student Eyes

In a 2000 issue of *Assessing Writing* dedicated specifically to response, Louise Wetherbee Phelps writes that since the 1980's the term "response" has come to refer to the writing done on or about student texts, by the teachers. Phelps claims that this envisioning of response as an act of rhetorical analyzing and as a commentary on text, "is legitimate and fruitful as long as it helps us conceive of response texts relationally, as an element that, together with others, constitutes a larger whole" (92). Jane Mathison Fife and Peggy O'Neill, in their 2001 article, "Moving beyond the Written Comment: Narrowing the Gap between Response Practice and Research," make a similar claim, but from another angle, saying that while response practices have changed dramatically in the last 20 years, empirical research has lagged behind what is actually practiced in the classroom, and focusing mainly on instructors' written comments as the text that makes up *response*. "By broadening our notion of response—and acknowledging the many and varied ways that teachers respond to student writing as well as the many and varied ways that students influence and interpret those responses—we will be able to narrow the gap between our teaching practices and our research questions" (300). Since response is a place where instructors are directly interrupting student writing process, Fife and O'Neill report on the abundance of studies that have focused on that instructor commentary, and how to preserve the student writer's autonomy in the midst of it. But as important as student autonomy is, they wonder why, while pedagogies have gone on to embrace social construction, empirical research has mostly focused on teacher's written comments, as if they have been composed in a vacuum; this approach does not account for the layered complexities within teaching practices today. "These research practices are problematic because just as they tend to study teacher comments in a vacuum, disconnected from other teaching practices and their collective effects on student writing, they also tend to offer advice for pedagogical practice that

envisions teachers commenting in a vacuum, separated from the rest of what we do as writing teachers” (301).

Over a decade later, when the progress of technology and access to digital composing is forcing the field to redefine the meanings and limitations of “text,” it should be obvious to us that instructor commentary is but a subtext within the larger Text created by the experience of instructor/student interaction. When the field is embracing new media and exploring the teaching and analyzing of broader definitions of Texts, its theory of response needs to embrace the same stretching of its definitions: yes, instructor response on student writing is a text and should be studied as such, but it must be viewed also *in time*, as a larger, ongoing response loop, where student writing responds to instructor practice, and instructors’ response is utilized by students to piece together elements of a larger Text that includes many more layers of interaction.

The difficulty with response scholarship is exactly the gap that Fife and O’Neill point to: much of what needs to be said about response has been said before. Nancy Sommers argues, in her 1999 essay “Afterword to ‘Responding to Student Writing,’” that “The key to successful commenting is to have what is said in the comments and what is done in the classroom mutually reinforce and enrich one another” (155). Why then, the gap between research and practice? Research should start, not with looking into how things should be, but how they are in the moment—and work from there. “How can we do X,Y, or Z, better?” is, in theory, a good place to start looking for answers, but doesn’t the gap between theory and practice within response scholarship make us wonder what other strategies might be used? Research into response effectiveness should start with the practices themselves, examining what is occurring within the larger Text of all channels of instructor/student interaction, find the discrepancies there, and *then* ask how to improve. Having spent the past year and a half researching students’ use of feedback

in FYC and the writing center (in ways I'll describe shortly), I saw exactly this: My central finding on how students are actually using feedback (versus how instructors tend to imagine their use) originated from practice. While I was looking for something else, the very language of the students illuminated their perceptions of response. Fife and O'Neill also argue that the practice of researching response as if it were composed in a vacuum is behind the current gap between practice and research, "This can lead to a bracketing off of response as a special subcategory of both composition research and pedagogical practice instead of a necessary connecting of response and its theory with the discussions that drive the rest of our teaching and research" (301).

Phelps points out that since the 1980's, response has been defined as the "writing that a teacher composes to student writers about, and often directly on, their drafts and final texts" (93). Thus many case studies of "response," are merely analyzing instructor commentary on/regarding student writing (and in later studies, students' response to that commentary). But "commentary" is the wrong metonym, Phelps claims, and while valuable knowledge has been gained by it, that knowledge is incomplete, at best. "The part chosen to stand for a whole needs to capture its essential character. In this case, the defining aspect of pedagogical response is not the teacher's rhetoric but the teacher's receptivity to student text (and what lies beyond it): Response is most fundamentally reading, not writing" (93). By focusing on instructor commentary alone and imagining we have studied response, we have obscured the fact that instructor response encompasses many more teaching acts than commentary—most that are invisible to the research. Response scholarship needs to look into the invisible aspects of feedback. To do that, we must redefine "response" to include more than instructor commentary on student papers: we can begin by studying what students themselves include in their definition of feedback, and observing how

they use it. By studying merely the visible portion of response alone, we have simplified a complex process and missed the dynamic motion of response concurrently influencing the nature of the student-teacher relationship. In Phelps' words, "Written commentary is only one instrument for taking action in direct response to student writing" (94). Conferencing, redesigning courses, defining new problems—all are pedagogical moves in response to student writing that are invisible to research on response when response is defined as instructor commentary on student writing. "In fact, the bulk of pedagogical response, largely invisible to response studies, occurs in teaching acts—inventions, changes, interventions—made as a consequence of reading student text but not in the form of commentary on them" (94-95).

Sandra Murphy, in offering her "sociocultural perspective" on response, writes that students can interpret instructor comments different ways based on a number of influences, including the situational context of the classroom, the student's individual learning style, and cultural differences—such as habits of responding to direct or indirect remarks, which may be confusing to those who are accustomed to one and are encountering the other (85-87). She comments on the accepted practice of using praise in response, draws attention to the possible pitfalls of praise (as reported by other scholars), and then drives home the complexity of the response loop I referred to earlier: "My point here is that, depending upon the situation, the abilities of the students, *and the ways students interpret our comments*, our good intentions might not be met" (84, emphasis mine). Murphy repeatedly points out the need for student perspective within our research. But clearly, to get student perspective means something other than asking students how well what *should* be working is working; the questions must start with lived experience, with practice. As Murphy concludes, "Teachers and researchers alike need to look more often at what students say about their understandings and their learning and to consider the

totality of *interactions* through which knowledge is constructed. We need to remember that there is a student in the room” (89).

Observations from my own Research

While researching military veteran students’ process of learning in FYC (Ford and Downs), I noted that students find this invitation to learn collaboratively with their instructor (rather than parrot back what they think they should be learning) difficult to believe; their instructor’s feedback is what mitigated the students’ skepticism. As a military veteran myself, I had experienced a clash between my definitions and expectations and those of the instructor’s—from the moment I first walked into my FYC class. However, the differences between the Discourse community (Gee) I was accustomed to (military training with its exigencies), and the one I was now attempting to merge with (academia) were invisible to me: all I could see was that my expectations for excellence were not being met, and the content of the class was expressed in such non-direct ways that I felt the material was irrelevant. *Something* would eventually mitigate my struggle, because I would go on to greatly appreciate the learning I did in that class—but even during that time of appreciative learning I did not know what was helping me move from viewing the class as irrelevant to embracing the learning opportunity it presented. A year or so later, having gained more knowledge of research practices, I wondered if other military veterans had faced similar challenges—and if so, was there something that could be done to improve veterans’ learning experience in FYC? While expecting a different answer from the one I eventually discovered, I kept returning to how important feedback seemed to be to the students I interviewed (all had, in various ways, similar experiences in FYC to mine). But the students (from several different military branches, attending different FYC classes at different institutions) were all referring to feedback differently than I expected: to them feedback was not

merely the instructors' written comments on their papers, but in-class discussion, emails, and other face to face interactions as well. Those students whose instructors used WAW pedagogy in their classrooms found themselves initially skeptical of the instructor's invitation to collaborative learning; those in FYC classes utilizing other pedagogies were similarly apprehensive when instructions were non-directive or asked for the student to voice their own opinions, or explore ideas as a group. Different from the traditional freshman's resistance to doing such work, the vets reasons rested in rigorous training that predisposed them to ways of responding that opposed the instructor's instructions. From the perspective of many of the vets in my study, instructors often automatically had the rank or role of a "superior," regardless of whether or not the instructor acted or desired the part. The veterans, based on knowledge and training from the Discourse community they brought with them into the classroom, expected that they must firmly know an answer before they talked about it: learning was something you did on your own, but when interacting with a superior there was no margin of "error" allowed—if you don't know exactly what you're talking about, then you don't talk about it. The very process of "learning" (not knowing everything about a subject, and voicing questions and thoughts about it anyway) was a concept they were uncomfortable with. For these students, what eventually built enough trust in the genuine nature of the instructor's invitation for their input (input that was fully formed or not) was instructor feedback. But according to these students, feedback was not only the instructor's text inscribed upon their text, it included every channel the instructor used to respond to them. As I did my research, my experience began to resound with what I was finding: In my experience too, it was the instructor's invitation to collaborate in my own learning—expressed to me consistently through all our channels of communication—that had eventually led me to see value in the class.

Feedback that undermined the invitational message

In contrast to the positive experience I and other students in WAW FYC courses ended up having, interviews with students who did not look back on their learning in FYC as being valuable showed some specific interactions that, to them, were challenging. Observations made from tutoring in the writing center and observing students in other classes confirmed the idea that it is crucial that the same invitation to collaborate be sent out on every channel of interaction with students. If it was not, then the focus of one kind of feedback contradicted the invitation issued in another. According to the students, such a contradiction made believing the sincerity of the instructor even more difficult than it already was. One example of this kind of contradiction was when the instructor stood in front of a class and told them, emphatically, that he didn't care about matters of correctness and wouldn't be grading on them; he wanted them to put all that hindrance out of their minds, wade into a new and difficult writing situation, look around, play around with writing, and see what they learned. However, when their papers came back to them, the instructor had substantially marked grammatical or syntactical errors, with less attention paid to how the students had followed his assignment. (He also didn't require any reflective writing regarding the students' experience with the assignment, so he was less informed of what their individual goals for the piece were and what challenges they encountered as they attempted to shape their paper. Had he asked for this information, it would have helped him know how to use his expert knowledge within his written responses to model for the students other ways they might have gone about conveying their intended meaning.) It was unclear to the students whether he had graded them on following the assignment or the correctness issues he marked. It is important to note that even the students who got A's on the assignment expressed deep

frustration and an unwillingness to take the instructor at his word the next time he asked them to see writing as something deeper and more complex than mere grammatical correctness. In class he had earnestly asked them to be collaborators in their own learning, but in the students' eyes, his written comments indicated that correctness was what he valued most of all, and so they disregarded his subsequent invitations to immerse themselves in new writing situations and learn from them, rather than trying to "do it right."

Feedback that reinforced the invitational message

An example of feedback bolstering trust in the instructor's invitation to collaborative learning came through one of the channels that a more holistic view of feedback includes: class discussion. Students I interviewed in the WAW FYC class found it particularly reassuring that when they dared to explore aloud an idea they weren't quite sure of, the instructor would say, "That's interesting. Tell me more." The students were conscious of the fact that they might be slightly off-topic, or unclear on what they were attempting to express (and they said in other classrooms, that consciousness would have prevented them from speaking up), but when the instructor appeared to find their ideas interesting, even when the instructor wasn't quite grasping the ideas, the students believed she was sincere in her desire to truly hear their knowledge and mix it with her own—to the end that they would both learn. This leads to the most marked difference in how students envisioned feedback: they called this process where they were giving and the instructor was receiving "giving the instructor feedback." They were shocked when she not only listened to their ideas, but actively solicited more expounding upon them, and then rephrased and repeated the idea to be sure she had heard their intent, rather than merely using their point to strengthen her own and plowing forward in her plans. This led the students to

believe that the instructor actually valued their “feedback,” and helped drive home a concept important to WAW: knowledge is epistemic—created by interchange of ideas and built upon interaction, rather than an intellectual item to be taken from the instructor and deposited into students’ heads. (And the instructor’s actual belief in this idea of epistemic knowledge engendered a desire to hear the student’s side; this is not, as other feedback scholarship seems to suggest, merely an attempt to turn a directive statement into a question. Genuine inquiry is present.) It is important to note that, for the students I interviewed, it was never the instructor’s initial invitation to collaborative knowledge-building that convinced the students to freely put their ideas on the table—it wasn’t even the second or third time she communicated her intention that convinced them. The ability for the students to trust her intent and participate to the degree she was asking of them grew slowly, usually during the first two or three weeks of class, as they saw the instructor consistently take the time to show her value of the students and the knowledge they brought into and collaboratively created in the classroom: through emails, through written responses on their papers, and during class discussions.

As I share the results of my research observations with instructors, the resulting conversations create more questions that further complexify those that remain unanswered regarding the role of invitational pedagogy and feedback within FYC courses. One question I am consistently asked regarding my research is for practical application: instructors want to know, specifically, what the students I observed found helpful. An important take-away from my research is just how differently an intended effect by the instructor can be experienced by students. In the end, students immersed in the invitational pedagogy report a sense of “being valued,” and those interactions that made all the difference to them were surprisingly simple for

the powerful effect they had on the students. There were three main things that conveyed that sense of being valued: being listened to, being asked for input, and having time invested in them.

There is a difference between being listened to and being actually heard. I observed the most effective instructors engaging in “interactive listening” where they waited patiently while the student talked, then repeated back what they understood the student to mean, followed by a genuine question that dug deeper into the issue the student had brought up. If there was confusion as to what the student was getting at, the instructor often said, “That’s interesting, can you say more about that?” Students I interviewed referenced this one phrase as serving a welcoming function that helped them worry less about how embarrassed they would feel if they didn’t make sense, and focus more on investigating the question that interested them. While this “Can you say more about that?” question issues by the instructor was part of the students feeling heard, it also served another function: it gave the students the sense that they were offering “feedback” to the instructor. Interactive listening. Response loops. A complex, multilayered Text that comprises response and feedback in ways we have only begun to imagine.

And what of the third interaction that helped students feel valued—and consequently more willing to walk beside the instructor down the path of learning, rather than lag behind and wait to be told what step to next? Having time invested in them. The students I observed—in my veteran research, in the writing center, and in my career as an undergrad—were constantly worried about taking up the instructor’s time. They would say things like, “I’ll let you go, I’m sure you have a lot of more important things to do.” It was clear from repetitive and frequent use of such language that these students didn’t realize that students are the important work an instructor does. Of course instructors are busy, but these students didn’t feel like their questions and interest were worth the instructor’s valuable time, when often the instructor was happy to

have a student show a genuine interest. Whenever and wherever the instructor took the time to interact with the students—again through any and every channel students refer to as “feedback”—the students were touched and impressed. The fact that they mattered enough to merit time was one more way that feedback helped them believe that the instructor did indeed want to learn from them as well as teach them, that together they would knowledge that neither of them could gain alone.

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Defining the Effectiveness of High-to-Low Speed Transitions along US Highway 93

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ABSTRACT

Increasing traffic volumes travelling through the small communities along US Highway 93 between Lolo, MT and Hamilton, MT have made the speed of the motorist a large concern for the various communities along the corridor. In an effort to increase the compliance with posted speed limits of the passing motorists various treatments within the transition zones, sections of highway in which the motorists change speed, have been implemented. These treatments include the use of raised medians, landscaping, and signage. To quantify the effectiveness of the treatments, speed data were collected and analyzed. Each location was then ranked based on five metrics. These rankings were then used to determine the most effective treatments. Each of the four sites studied used a different combination of treatments. The raised median with horizontal displacement in Victor had a 20-mph decrease in average speed from upstream to downstream. The raised medians with minimal horizontal displacement at both Stevensville and Woodside Cutoff had a combined average decrease in speed of 13.1-mph. Hamilton utilized only speed limit signage and had a speed decrease of 8.0-mph. The safety at these sites was not studied due to lack of crash data. Further study of the US 93 corridor could be performed to allow a comparison of the sites across a larger time frame.

1 Introduction

US Highway 93 (US 93) travels from the US-Canada border near Eureka, Montana to Kingman, Arizona. Along its path are large stretches of rural highway and various small communities. Of note for this study is the section of US 93 that connects Lolo, Montana with Hamilton, Montana.

With the completion of the Bear Creek South project in 2011 the corridor from Lolo to Hamilton is now a four lane highway for its entire length. Along this corridor are the small communities and various intersections.

Many of the small communities along this corridor require that motorists are slowed down from 65-mph (miles per hour) to 45-mph when entering the community. This speed decrease is accomplished through the use of transition zones. A transition zone is a section of roadway in which motorists are expected to slow down while traversing.

The main line speed limit from Stevensville to Hamilton is 65 miles per hour (mph). Four locations along this stretch of highway have a decreased speed limit of 45-mph. Each transition zone uses a different approach to decreasing the speed of the motorists. The treatments range from simple speed limit signs to complex raised medians with landscaping.

1.1 Literature Review

Many publications exist that discuss transition zones in various settings. Many of these documents focus on the effectiveness of various treatments to the roadway and surrounding area. However, no research was found that focused on transition zones with multilane highways.

Dixon, Zhu, and Ogle (2008) looked at various treatments for two lane highways including:

- layered Landscaping,
- gateway with lane narrowing,
- median treatment only,
- medians in series without pedestrian crosswalks, and
- medians in series with pedestrian crosswalks.

The conclusion was that median treatments were the most effective; however a reduction of only 0 to 5-mph was observed for the 85th percentile speeds when comparing the transition with and without the treatment.

Dixon, Zhu, and Ogle also looked at the use of horizontal displacement in creating a gateway into the urban area. Horizontal displacement is intended to modify the vehicle path so that there is less available space to maintain high speed operation. It was also found that by combining treatment methods, a greater decrease in speed of 2 to 4-mph was noted

The use of medians and landscaping to create a gateway was found in many publications. Galente et al. (2010) focused on the use of gateways in decreasing speed through the transition zone. By using a high fidelity driving simulator, Galente et al. was able to test multiple alternative gateway designs. These designs utilized overhead features, road geometry changes, and landscaping. It was found that with a gateway the mean reduction of speed was 5.5-mph to 9.5-mph as compared to the speeds determined without the gateway. One option within the alternatives was the use of a raised median that created horizontal displacement for incoming traffic but allowed the outgoing traffic to move unimpeded.

Godley et al. (2004) argued that by narrowing the perceived lane width the mental work load of the drive was increased. The increased mental work load would lead to slower speeds. Godley et al. used a simulator to test the effectiveness of seven different roadway configurations. By using the simulator, data on speed, standard deviation of lane placement, and standard deviation of steering wheel angle were collected and analyzed. Participants in the study were asked to fill out a survey that was meant to quantify the mental work load. The study concluded that decreased lane widths showed a decrease of 2.23 kilometers per hour (kph) with the 2.5 meter lane widths. It was also seen that greater steering wheel deviations, movements of the steering wheel left and right, were noted with narrower lane widths, indicating that greater steering effort is required.

Allpress and Leland Jr. (2009) looked at a different type of transition zone, construction zones. Of note from this study was effect that objects in the peripheral view of the driver have on the speed of the vehicle. The arrangement of road cones on the side of the travel lane was studied to determine its effect. The two arrangements that were tested were even spacing and decreasing spacing. It was found that the decreasing spacing showed a decrease of 9.47-kph when compared to the even spaced cones. In addition to the average speed the number of dangerous speeders, those travelling 20-kph (12-mph) over the speed limit, were investigated. There was no difference in the number of speeders between the two arrangements.

Forbes (2011) utilized surveys sent out to the Department of Transportation in each state and to each province in Canada. From the survey responses Forbes was able to create a summary of the state of the industry as far as transition zones are concerned. It was found that transition zone treatments ranged from the less expensive use of signage to the more expensive use of geometric treatments. The survey also requested information on the public response of various treatments. This report did not make any suggestions as to the best method; instead it simply tabulated the commonly used methods. The following is a list of commonly used transition zone treatments that Forbes included within the study:

- central islands/raised medians,
- roundabout,
- road or lane narrowing,
- road diets,
- chicanes or horizontal deflections,
- countdown speed signs/markers,
- speed feedback signs,
- speed-activated speed limit signs,
- transitional speed limits,
- removal of pavement markings,
- optical speed bars,
- speed humps, raised crosswalks, raised intersections, and vertical deflections,
- rumblewave surfaces, and
- and gateways.

The relationship of posted speed and actual speed of a roadway segment was investigated by Fitzpatrick et al. (2003). Of note was the following statement:

“Only between 23 and 64 percent of drivers operate at or below the posted speed limit on non-freeway facilities. The legal speed limit plus 10-mph include at least 86 percent of suburban/urban drivers on non-freeway facilities with speed limits of 25 to 55-mph and included at least 96 percent of rural drivers on non-freeway facilities with speed limits of 50 to 70-mph.”

This statement will be useful in the determination of how closely the posted speed limit is being obeyed by those using the road way.

Ray et al. (2008) studied the effects on treatments at high-speed intersections. It was found that the use of raised medians at an intersection created a 30 to 60 percent reduction in fatal, injury, and pedestrian crashes. Three other treatments were inspected: reduced lane width, visible shoulder treatments, and roadside design features. All three treatments showed an increased work load for the drivers and therefore a decrease in speed.

1.2 *Scope of Research*

The effectiveness of the various treatments utilized on US 93 between Stevensville and Hamilton will be quantified through a comparison of the speeds at the end of the transition zones. The results for each site will be compared to one another in order to rank the effectiveness of the treatments. With the four sites being located along the same highway it will be assumed that the traffic characteristics are the same at each site. The remainder of this document details the methods used, the sites investigated, the data collected, and the results found by analyzing the data.

2 **Methodology**

The following sub-sections outline the methods for site selection, data collection, and data analysis.

2.1 *Site Selection*

US 93 between Lolo, MT and Hamilton, MT has six sections with a decreased speed limit with transition zones on each end. Of these sites two of them have a transition of speed from 70-mph to 45-mph while the remaining six have a transition from 65-mph to 45-mph. For this study four locations with the 65-mph to 45-mph transitions will be compared. At two sites the north bound traffic was measured, for the other two the south bound traffic was measured.

The two locations for spot speed measurements were based on the first occurrence of a treatment and the 45-mph speed limit sign, upstream and downstream respectively. The upstream location varied from the beginning of a raised median to a sign stating a decrease of speed was ahead.

2.2 *Data Collection*

The spot speed data were collected using a hand held radar gun. By placing the radar gun operator as close to the travel lanes as safety would permit, the angle between the travel direction of the vehicles and the line of sight from the radar gun to the vehicle was minimized. By minimizing the angle the systematic error is reduced (Roess, Prassas, & McShane, 2011).

To ensure a random sampling the speed of every vehicle in each lane was measured. A minimum of 50 spot speeds were recorded at the high speed end of each transition zone in order to establish the main line speed of the incoming traffic. At the low speed end of each transition zone at least 100 spot speeds were measured to ensure a statistically significant number of speeds were recorded (Roess, Prassas, and McShane). Spot speeds for a total of eight locations were collected. Speed data and the form used to record the data can be found in Appendix A.

2.3 *Statistical Analysis*

The following statistics, taken from Roess, Prassa, and McShane, were used to describe the spot speed distribution:

- *Spot or time mean speed:* The average speed of all vehicles passing the study location during the period of study.
- *85th percentile speed:* The speed below which 85 percent of the vehicles travel.

The proportion of dangerous speeders was also calculated. A dangerous speeder was a vehicle travelling at a speed greater than 12-mph over the posted speed limit (Allpress & Leland Jr., 2009).

2.4 Data Comparison

The effectiveness of each site treatment will be determined by comparing the five metrics below. Each site will be ranked, based on each of the metrics and a final rank will be determined and compared. The ranking will be on a scale of one to four with one being the best. The sum of all five metric ranks will be compared, with the lowest sum being the best, to determine the final ranking.

2.4.1 Lowest 85th Percentile Speed at 45-mph Zone

The 85th percentile speed should be within 10-mph of the posted speed limit for all of the treatments (Fitzpatrick, Carlson, and Brewer, 2003). The site with the lowest 85th percentile speed at the beginning of the 45-mph zone will receive the best rank.

2.4.2 Lowest Average Speed at 45-mph Zone

The average speed at the beginning of the 45-mph zone will be compared. The best rank will be given to the treatment with the lowest average speed.

2.4.3 Comparison of Up-stream and Down-Stream Speeds – 85th Percentile Speed

The reduction of the 85th percentile speeds from the beginning to the end of the transition zone will be calculated. The site with the greatest decrease will receive the best rank.

2.4.4 Comparison of Up-stream and Down-Stream Speeds – Average Speed

The reduction of the average speeds from the beginning to the end of the transition zone will be calculated. The site with the greatest decrease will receive the best rank. The difference between the average speeds is not necessarily the same as the difference between the 85th percentile speeds.

2.4.5 Proportion of Dangerous Speeders at 45-mph Zone

Rank will be given based on the proportion of dangerous speeders at the end of the transition zone. The site with the lowest proportion of dangerous speeders will be given the best rank.

2.5 Apparatus

The apparatus used for this study was simple with only a hand held radar gun and a measuring wheel. The radar gun was a Bushnell model number 10-1900, with a reported accuracy of plus or minus one mile per hour. The measuring wheel was a generic measuring wheel that measured distance in feet with an accuracy of plus or minus one tenth of a foot.

3 Site Descriptions

The US 93 corridor connects Lolo, Montana with Hamilton, Montana. The 36-mile long stretch of highway has four travel lanes. This multilane highway passes through the small communities of Florence, Stevensville, and Victor. At each of these communities see the speed limit decrease from 65-mph to 45-mph. Throughout this section of highway the travel lanes are

12-feet wide with the exception of Victor. Maps and tabulated descriptions of each transition zone can be found in Appendix B.

3.1 Stevensville – South End

The first indication of a change in speed limit that a motorist travelling north on US 93 into the Stevensville area will encounter is a “Speed Limit 55 ahead” sign and a raised center median with landscaping. Soon after the beginning of the raised median the motorists will see a large “Welcome to Stevensville” sign on the right hand side of the road. The speed limit is then reduced to 55-mph. At the end of the transition zone the speed limit is further decreased to 45-mph. The total length of the transition zone is 3156-feet.

Urban build up along the transition zone is minimal to none. Overhead lighting is present throughout the transition zone. A traffic signal is visible at the intersection of US 93 and MT Secondary 269 just beyond the end of the transition zone. The intersection has a medium amount of urban build up.

3.2 Victor – South End

Victor utilizes medians in a more obtrusive manner. When travelling into Victor from the south, motorists encounter a raised median with landscaping and a gradually increasing width (maximum width of approximately 70-feet). This median creates horizontal displacement of the traffic flow and encourages the motorists to slow down (Forbes, 2011). This raised median is the first indication of a transition into an urban area.

When motorists first encounter the median the speed limit is still 65-mph. A “45-mph ahead” sign is located near the widest portion of the raised median. The raised median gradually decreases in width until it terminates near the intersection of US 93 and Victor Crossing Road. A structure for is in place for a “Welcome to Victor” sign (at the time of the site visit the sign was not in place). The end of the transition zone is marked by the 45-mph speed limit sign. The total length of the transition zone is 2122-feet.

The transition zone is fully lighted with overhead lighting. This is the only transition zone that was inspected that did not use a 55-mph transitional speed limit within the transition zone. The inside travel lane through this area is also wider at 14-feet. Light urban build up is present on the east side of US 93 within the transition zone. After the transition zone a large degree of urban build up is present.

3.3 Woodside Cutoff – North End

Woodside Cutoff is an intersection of US 93 and MT 373. This area has a medium amount of urban build up along the west side of US 93. The intersection is controlled with a traffic signal. The speed limit entering into the area is 65-mph.

The first indication of a decrease in speed limit when traveling south on US 93 is a “55-mph speed limit ahead” sign. The speed limit is decreased to 55-mph then further decreased to 45-mph. At the same location as the 45-mph sign a raised median with landscaping begins. Visible from the transition zone is an overhead sign warning of the upcoming traffic signal. The total length of the transition zone is 1716-feet.

The transition zone is fully lighted with overhead lighting. At the intersection of US 93 and MT 373 a large degree of urban buildup is present.

3.4 Hamilton – North End

The transition zone entering Hamilton from the north is the most basic of all those studied. Signage is the only treatment employed by this transition zone. Throughout this transition zone the cross-section remains the same with four travel lanes and no shared center lanes. A transitional speed limit of 55-mph is used to step down the speed of traffic. The total length of the transition zone is 3156-feet.

A small intersection with Bowman Road is located near the end of the transition zone. This intersection does have a dedicated right hand turn lane for the south bound traffic and a dedicated left hand turn lane for the north bound traffic. The only overhead lighting within this transition zone is at this intersection. The only signs of urban build up are a concrete batch plant on the west side of US 93.

4 Data

Spot speed data was collected on Monday, June 18, 2012. The weather was fair with no hard rains and mostly sunny skies. Raw data for each location can be located in Appendix A. Details of the statistical analysis can be found in Appendix A. A summary of the data can be found in Table 1.

Table 1: Summary of Data

Speed Zone	Stevensville		Victor		Woodside Cutoff		Hamilton	
	65-mph	45-mph	65-mph	45-mph	65-mph	45-mph	65-mph	45-mph
Mean Speed (mph)	60.6	45.0	63.2	43.2	57.5	47.0	59.2	51.1
Median Speed (mph)	60.6	45.0	63.0	43.2	57.4	46.8	59.0	51.0
85th Percentile Speed (mph)	65.0	50.4	67.0	47.2	63.2	51.6	64.2	55.6
Dangerous Speeders	0.0%	1.0%	0.0%	0.0%	0.0%	2.5%	0.0%	13.7%

4.1 T-Tests

Standard t-statistics were calculated to ensure that the measured average speeds were statistically different for the low-speed end of the transition zones. An alpha value of 95 percent was utilized for a two sided t-test. Table 2 shows each site in relation to the other sites. It was found that all of the average speeds were statistically different. This is important to confirm as it allows for a direct comparison to be made between each site although each is a different location, the primary difference is the transition zone treatment.

Table 2: T-Test Summary

		μ_2			
		Hamilton	Woodside	Victor	Stevensville
μ_1	Hamilton	-	Accept	Accept	Accept
	Woodside	Accept	-	Accept	Accept
	Victor	Accept	Accept	-	Accept
	Stevensville	Accept	Accept	Accept	-

$H_1: \mu_1 \neq \mu_2$ $\alpha=95\%$

5 Discussion of Data

Through the use of the five metrics for comparison, each site was ranked for its effectiveness when compared to the other sites. A summary of the ranking can be found in Table 3.

Table 3: Summary of Site Ranking

	Stevensville		Victor		Woodside Cutoff		Hamilton	
	Value	Rank	Value	Rank	Value	Rank	Value	Rank
85th percentile speed at 45-mph zone	50.4-mph	2	47.2-mph	1	51.6-mph	3	55.6-mph	4
Average Speed at 45-mph zone	45.0-mph	2	43.2-mph	1	47.0-mph	3	51.1-mph	4
Upstream versus Downstream - 85th percentile	14.6-mph	2	19.8-mph	1	11.6-mph	3	8.6-mph	4
Upstream versus Downstream - Average	15.6-mph	2	20.0-mph	1	10.5-mph	3	8.0-mph	4
Dangerous Speeders at 45-mph zone	1.0%	2	0.0%	1	2.5%	3	13.7%	4
Total Score	10		5		15		20	
Final Rank	2		1		3		4	

5.1 85th Percentile Speeds at the 45-mph Zone

The 85th percentile speed was expected to be near or just above the posted speed limit (Fitzpatrick, Carlson, and Brewer). Each site, with the exception of Hamilton, had an 85th percentile speed that was within the expected 10-mph above the posted speed limit. This fact was reflected in the rankings.

5.2 Average Speed at 45-mph Zone

The average speed of the two highest ranked sites, Victor and Stevensville, were found to be at or below the posted speed limit. The other two sites, Woodside Cutoff and Hamilton, had an average speed that was greater than the posted speed limit. Hamilton had the highest average speed.

5.3 Upstream Versus Downstream Speed – 85th Percentile

The decrease in speed through the transition zone can be found by comparing the 85th percentile speeds at each end of the transition zone. The reduction in speed varied from 19.8-mph at Victor to only 8.6-mph at Hamilton. The ideal decrease in speed would have been 20-mph, the difference of the posted speed limits.

5.4 Upstream Versus Downstream Speed – Average

The decrease in the average speed was very similar to the decrease in the 85th percentile speed. Again Victor had the greatest decrease in speed with 20.0-mph and Hamilton had the lowest with a decrease of 8.0-mph.

5.5 *Number of Dangerous Speeders at 45-mph Zone*

The number of dangerous speeders at each site at the high speed end of the transition zone was zero. At each site no dangerous speeders were seen at the 65-mph end of the transition zone. In all but Victor dangerous speeders were seen at the 45-mph end of the transition zone. Hamilton had the largest number of dangerous speeders at 13.7 percent of total motorists.

5.6 *Rankings*

The site rankings followed with the amount of treatment applied to each site. Victor had the most visually obvious treatments: large raised medians with landscaping and horizontal displacement. These treatments helped to create a gateway like effect for the motorist coming into the community (Dixon, Zhu, and Ogle, 2008).

Stevensville utilized raised medians with landscaping and gateway signs to help the motorists determine that a decrease in speed was ahead. With the transition zone being straight and long, 3160-feet, it would be easy for motorist to see the traffic signal just after the end of the transition zone. An uphill grade through the transition zone may have also helped to decrease the speeds of the motorists.

The area around the Woodside Cutoff intersection has a large degree of urban build up and clear lines of sight for the motorists. At the beginning of the transition zone is a raised median with landscaping. This landscaping extends only to the beginning of a left hand turn lane after which only a raised median exists. This transition zone also has a traffic signal after the median but at a much greater distance of 580-feet. The urban build up on the sides of US 93 begins before the start of the transition zone and continues through the whole transition zone. (Ray, Kittelson, and Knudsen, 2008)

Hamilton utilized the least amount of treatments. No change in cross-section or landscaping exists within the transition zone. The transition zone is on a large horizontal curve. This curve hinders the view of Hamilton proper. Using only speed limit signs to decrease the speed of the motorists and giving no other indications of the community ahead resulted in the lowest decrease in speed and the highest number of dangerous speeders. The speeds at the 45-mph end of the transition zone were found to be a large degree above the posted speed limit, 6.1-mph.

6 Discussion of Treatments

Treatments across the four sites varied in complexity and visual impact. Having no treatments, Hamilton is a good baseline to compare the other sites to. The basic treatments at the Woodside Cutoff resulted in a reduction of speed through the transition zone. This decrease was greater than that seen at Hamilton. The urban build up around the Woodside Cutoff area also helped to set it apart from the other sites as no other site had a large amount of build up.

Stevensville utilized many of the same features as the Woodside Cutoff area. The inclusion of the “Welcome to Stevensville” (Figure 1) sign along the road side and the longer landscaped raised medians helped to create a more gateway like appearance to the transition zone. This appearance was not present at Hamilton.

By using a raised median to create horizontal displacement of the traffic flowing into Victor (Figure 2) the transition zone was the most effective of the four zones. The large median coupled with landscaping helps to notify the motorists that they are entering an urban area.



Figure 1: Welcome to Stevensville

Victor was also the only site to not use a 55-mph step within the transition zone: instead the speed limit decreased from 65-mph to 45-mph in one step.

The varying treatments used at each of the four sites have a varying degree of expense. The lack of treatment at Hamilton would be the lowest cost solution, Stevensville and the Woodside Cutoff area would be next in expense, and Victor would be the most expensive (Ray, Kittelson, and Knudsen, 2008). Victor was also the only site that would require a large amount of land acquisition along the road side.



Figure 2: Raised Median in Victor

7 Conclusion

Transition zones into communities play a large role in the speeds that motorists travel through the community. Many factors (weather, time of day, or traffic intensity to name a few) exist that can affect the speeds that the motorists choose. By using many different methods to indicate a change in speed ahead the motorists will be more likely to decrease their speed. The varied treatments used on US 93 shows that with increased visual cues a greater degree of speed change can be expected.

The familiarity of the drivers with the treatments is sure to impact the effectiveness of the treatment over time. The treatments at Victor had been in place for less than one year at the time of this study. Before the construction of the current configuration of Victor, US 93 had two travel lanes through the urban area. A large change in traffic control, like the one used in Victor, will take time for motorists to become familiar with.

8 Suggestions for Further Research

This study has shown that on Monday, June 18, 2012 the motorists travelling into Victor, Montana from the south end of the community showed a greater decrease in speed as they entered the community when compared to sites with other treatments. With only data for one small amount of time throughout the year it is hard to state that this trend will hold throughout the year. Further data collection could help to better define the effectiveness of the transition zones along US 93.

The speed data was collected in way that made the measuring highly visible to the motorists using the facilities. The use of road tubes to collect speed data would help to eliminate this visibility of the data collection. Road tubes would also allow for larger amounts of data to be collected over a long time span and to measure all four sites simultaneously. With simultaneous data, collection time effects, lunch time or peak traffic flows, could be directly compared.

The safety of the facilities was not studied due to lack of crash data. Construction on the Victor transition zone was completed in 2011, six months prior to this study. In the future, crash data will exist for the area and can be compared to other transition zones in the area. During the site visit some indications of erratic maneuvers, such as tire marks, were seen on the raised median of the Victor transition zone. This observation could lead to the conclusion that decreased speed may not equate to an improvement in safety.

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Title: Bovine *in vitro* fertilization and embryo development using nano-particle depleted spermatozoa

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Abstract:

In beef cattle, fertilization rates to a single service by natural service breeding or artificial insemination are between 90 and 100%. Field studies suggest that approximately 10% of embryonic mortality is the result of fertilization with defective sperm or sperm with suboptimal fertility. Therefore, the purpose of this study was to determine if *in vitro* fertilization and development could be used to help identify bulls with sub-fertile spermatozoa. Our hypothesis was that nanoparticle depleted semen (semen free of certain abnormalities) would increase fertilization and early embryo development by removal of compromised sperm. Semen from three bulls was sorted with two different methods (ubiquitin antibody or Lectin *Arachis hypogaea* agglutinin “PNA”) and one remaining untreated sample for a control from each bull. Ten ovaries were obtained from a local abattoir. Oocytes from these ovaries were collected using standard techniques and matured *in vitro*. Approximately 100 oocytes were obtained for each semen treatment per bull. Matured oocytes were fertilized with semen from 1 of 3 treatments and cultured *in vitro* for 8 d. The number of oocytes that were fertilized and had undergone embryo cleavage was recorded 3 d following fertilization. In addition, the number of embryos that reached blastocyst formation by d 8 after fertilization

was recorded. Fertilization and embryo development were compared between semen treatments and to a field study that used the same bulls and semen treatments. The development of laboratory procedures as used in the current study that mimic results of field trials may lead to more rapid improvements in livestock fertility for producers using artificial insemination. At this time, no results have been obtained. However, this study will be continued in the summer of 2013, and we anticipate that it will reveal critical information about semen characteristics related to early embryonic mortality, and thus, provide a more accurate measure of semen fertility than is currently available.

1. Introduction

In beef cattle, it is generally accepted that fertilization rates to a single service are between 90 and 100% regardless of whether natural service or artificial insemination is utilized (Diskin and Sreenan, 1980). Yet, rarely more than 70% of matings result in a positive pregnancy diagnosis 30 days later and even fewer result in a live birth. The majority of embryonic mortality is early embryonic mortality, with rates ranging from 20 to 44% reported in beef cattle (Humblot, 2001) and may be greater than 50% in dairy cattle (Santos et al., 2004). Preliminary data from our laboratory suggests that greater than 10% of embryonic mortality is the result of fertilization with defective sperm or sperm with suboptimal fertility. Conducting field studies to identify the causes of subfertility and embryonic loss related to bulls are expensive and difficult. Development of laboratory procedures that mimic results of field trials would allow more rapid improvements in livestock fertility.

The protein ubiquitin is produced by cells that are damaged and beginning to die. Thus, sperm cells that contain ubiquitin on their cell surface are dying and marked for degradation and reabsorption by the immune system. However, this does not prevent these cells from being present in ejaculate from males. Nano-particle depletion includes the use of magnetic nano-particles coated with the ubiquitin antibody (in this case) to sort

semen that are labeled with ubiquitin. Nano-particle antibodies recognize and bind to sperm marked with ubiquitin protein and these sperm are removed from the ejaculate using a magnetic field (Geary, 2012). Lectin *Arachis hypogaea* (peanut) agglutinin (PNA) is a protein that binds to the acrosomal surface of sperm that have acrosomal damage (Odhiambo et al., 2011). Normally, the acrosomal membrane of sperm cells is not exposed until they have resided within the female reproductive tract for a period of time and are prepared for fertilization. It is unclear how presence of greater concentrations of acrosome damaged sperm in an ejaculate are related to subsequent embryonic development, but perhaps it is indicative of sperm chromosomal damage that impedes embryo development. Similar to ubiquitin, magnetic nano-particles can be coated with PNA and a magnetic field applied to remove acrosome damaged sperm from an ejaculate. Semen from these fertility enhancing treatments can be packaged in straws and frozen for use in the AI industry. Therefore, these treatments should increase the likelihood of fertilization to fully competent sperm following AI and decrease embryonic mortality. This technology decreases the possibility that sub-optimal or damaged sperm will fertilize an oocyte, therefore improving embryonic and fetal survival. The goal of this research was to establish the procedures for in vitro fertilization (IVF) in our laboratory and evaluate these fertility enhancing semen treatments.

2. Methods

2.1 Day -1

Bovine embryos were created using IVF protocols from Dr. Peter Hansen's laboratory at the University of Florida. Ovaries were dissected from female reproductive tracts collected at a local slaughterhouse (Montana Quality Foods, Miles City, MT). In a 15 x 60 mm petri dish, 50 µl drops (microdrops) of oocyte maturation media covered in mineral oil were allowed to equilibrate for 2 h in a 37°C incubator before cumulus oocyte complex (COC) collection. Oocyte maturation media included Medium 199 with Earle's Salts (OMM, Invitrogen) supplemented with bovine steer serum, gentamicin, sodium pyruvate, Glutamine, FSH, and Estradiol. Ovaries were transported in a thermos filled with 0.9% saline solution to the lab. Fresh saline was used to clean the ovaries from blood and other tissue remaining in solution from dissection. A hemostat was attached to the base of the ovary. Oocyte collection medium (OCM, Sigma-Aldrich Co.) included Medium 199 with Hank's Salts and L-Glutamine, supplemented with Sodium Bicarbonate double distilled H₂O, and penicillin-streptomycin. A beaker with 75 ml of OCM was placed under an ovary and 3 mm incisions were made directly on the follicles parallel to each other with a scalpel blade. Submersion of the ovary, along with vigorous swirling rinsed the COCs from the follicular cavities. Any remaining OCM was removed from the ovary by pressing the ovary against the wall of the beaker. The OCM containing the COCs was strained through a 0.22 micrometer strainer into a fresh beaker. With a 12 ml syringe and a 20 gauge needle the beaker was rinsed a final time with OCM. The strainer was then turned upside down over a previously scored 15 x 100 ml petri dish and COCs rinsed from the filter with OCM. A dissecting microscope was used to search for and collect COCs. All COCs were washed 4 times

in OCM and placed into OMM drops, 10 COCs per drop. COCs were incubated at 38.5 degrees Celsius in 5% CO₂/20% O₂/75 % N₂ atmosphere overnight.

2.2 Day 0

Microdrops (50 µl each) containing Synthetic Oviduct Fluid- Fertilization (SOF-Fert; Sigma-Aldrich Co.) were made under oil and equilibrated in the incubator two hours before transfer of COCs for fertilization. Fertilization media contained SOF stock solution supplemented with essentially fatty acid-free bovine serum albumin, sodium pyruvate, and heparin. Spermatozoa were prepared for fertilization using a Percoll gradient swim-up procedure that included a pre-warmed micro centrifuge tube containing 1 ml of 45 % Percoll on top of 90% Percoll. As well, 1 milliliter of Sperm-Tyrode's Albumin-Lactate-Pyruvate in a micro centrifuge tube was warmed in the incubator. Sperm-Tyrode's Albumin-Lactate-Pyruvate (Sp-TALP; Caisson, Sigma-Aldrich Co.) consisted of Sperm-TL supplemented with Bovine Serum Albumin Fraction V, Sodium Pyruvate, and Gentamicin. Sp-TALP was used to wash sperm after the Percoll gradient procedure.

In a 38.5 °C water bath one semen straw was thawed for 45 seconds. The straw was removed, wiped dry, and semen was deposited gently into the Percoll layered solution. The micro centrifuge tube was then centrifuged for ten minutes at 1000 RCF. Using a Pasteur pipette, the supernatant was removed only leaving the pellet in the tip. One milliliter of warmed Sp-TALP was then added and centrifuged for two minutes at 200 RCF. Again, the supernatant was removed. Ten microliters of

sperm was diluted 90 μ l of water. Ten microliters of diluted sperm was used to estimate sperm concentration and sperm was diluted to a final concentration of one million sperm per milliliter using pre-warmed Tyrode's Albumin-Lactate-Pyruvate. In vitro fertilization-Tyrode's Albumin-Lactate-Pyruvate (IVF-TALP; Caisson, Sigma-Aldrich Co.) included IVF-TL supplemented with essential fatty acid-free bovine serum albumin, sodium pyruvate, gentamicin, and heparin. Pools of COCs were removed from maturation drops and washed 4 times in HEPES- Tyrode's Albumin-Lactate-Pyruvate (HEPES-TALP; Caisson, Sigma-Aldrich Co.). The HEPES- TALP included HEPES-TL supplemented with bovine serum albumin Fraction V, sodium pyruvate, and gentamicin. After washing, COCs were placed in SOF-FERT microdrops, along with 20 ml of prepared sperm, and 3 ml of PHE. The PHE was a solution consisting of penicillamine, hypotaurine, and epinephrine. Fertilization microdrops were incubated for 18 hours at 38.5 °C.

2.3 Day 1

A plate of Synthetic Oviduct Fluid-Bovine Embryo microdrops was made and equilibrated in a modular growth chamber containing the appropriate gases. Synthetic Oviduct Fluid- Bovine Embryo (SOF-BE1; Sigma Aldrich) included SOF stock solution enhanced with essential fatty acid-free bovine serum albumin, ALA-glutamine, sodium pyruvate, non-essential amino acids, and essential amino acids. The modular growth chamber was filled with 5% CO₂/ 5% O₂/90% N₂ gas. In a microcentrifuge tube, embryos from the SOF-FERT plate were added to 500 ml of warmed HEPES-TALP. This tube was vortexed for four minutes to disperse cumulus

cells from embryos and unfertilized oocytes. Using a Pastuer pipette, the microcentrifuge tube was flushed twice into a 15 x 60 mm petri dish. The embryos were recovered and deposited into the SOF-BE1 microdrops and returned to incubation at 38.5 °C in the modular growth chamber.

2.4 Assessments

All assessments were completed under a dissection microscope.

- Day 3- Embryos should have reached 8-cell
- Day 8- Embryo formation of Blastocyst
- Day 11- Blastocyst
 - Termination day

3. Results

No results have been obtained at this time.

4. Future Research

At this time, no results have been obtained. However, this study will be continued in the summer of 2013, and should reveal information about semen quality and early embryonic mortality.

5. Discussion

Less than 5% of beef cattle are artificially inseminated annually in the United States (Geary & Ansotegui; 2004) using semen from genetically superior bulls. If an increase in artificial insemination (AI) conception rates can be obtained, this would significantly reduce the risk acquired by the producer. This reduction of risk would make AI more appealing to producers. Utilizing superior genetics through AI could boost the value and quality of beef and beef cattle as well as improve milk production in dairy cattle. Semen sorting success investigated by this research may reveal possible industry changes.

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The Making of an Effective Visitor-Orientated Museum

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A museum is an institution whose purpose is to serve and educate the public while preserving history through its collections; however, a museum cannot exist without its visitors. Although strong research programs and rich collections are important and essential items to a museum, a research program without visitors is simply a research facility; and a museum with excellent collections but without visitors is only a collection. Visitors are essential to a museum's success. A museum's effectiveness can be evaluated on its research programs, collections or visitor experiences. This paper, however, will focus on visitor experience, as it is the most vital element of a museum's existence. There is no way to conjure a list of ways a museum can be effective for visitors and there is no formula to follow. The only way to discover a museum's effectiveness is to observe quality museums. By visiting a variety of museums, I was able to deduce some aspects of a successful museum that make it visitor-orientated.

Interesting subject matter is essential to an effective museum. Artifacts are, of course, in themselves interesting; but in order to create a connection with visitors, artifacts should relate to the them. Artifacts must be able to make a connection between visitors and exhibits. According to Nina Simon "When visitors see an object in a case that they have a personal connection to, they have an immediate story to tell" (Simon 130). When visitors can personally connect with exhibits they are more likely to return to the museum and encourage others to visit as well. However, it must be understood that although an exhibit may strive to connect with the visitor, "not every artifact stirs a personal response. It is easy for staff members to forget that visitors may not have personal relationships with many artifacts" (Simon 130). Even so, it is important for museums to make every effort to create a personal connection with the visitor. The Fort Bliss and Old Ironsides Museums in El Paso, Texas are examples of this practice in action.

The Fort Bliss and Old Ironsides Museums detail the involvement of Fort Bliss in military campaigns from the inception of the fort in 1848 to present day. These museums are not the best examples of museums as they are located in an old grocery store, the layout of the exhibits is awkward, and the museums were void of any visitors and lacked a visible staff. Despite these pitfalls, the way in which these museums trace the history of Fort Bliss connects well with the visitor. The prospective visitors of this museum probably have some sort of connection to the military, be it serving or having served in the military or simply knowing

someone who has worked with the military. Because of this, the history of the Fort is of interest to the visitor. The same troops and units that existed fifty years ago still exist today and the visitor is able to trace his or her connections back to the Fort's beginnings.

The museums' exhibits begin with the formation of Fort Bliss and its involvement as a cavalry camp. In one of these exhibits children are given the option to pack their knapsack for a trip with the cavalry and then compare their choice with the ideal choices to see if they chose wisely (e.g. see fig. 1). This element of the exhibit allows children, who may find it harder to connect with the history of Fort Bliss, the opportunity to build their own connections to the museums. The museum continues to document



Figure 1 Pack your Knapsack activity for children. This activity encourages children to become their forefathers and pack their bags for a scouting trip. It teaches them the history of Fort Bliss while allowing them to interact with the exhibit.

Fort Bliss' history including its troops' involvement in WWI and WWII. The museums do a great job in displaying the large WWI and WWII vehicles in the context in which they were used. They are displayed in an area that has been decorated to look like 1940's France. By displaying the vehicles in this context it allows the visitors to imagine what the setting would have looked like. They can see the towering tanks compared to the small coffee shops and can imagine what it would have been like to walk among these giants (e.g. see fig. 2). This exhibit enables visitors to bring a world event into the context of their lives by connecting on a personal level with the artifacts. Their loved ones, who now serve at Fort Bliss, may have served in the same units in which the artifacts were once used.



Figure 2 The layout of the World War I and II vehicles exhibit. This exhibit places the large vehicles in the context of the petite French cities they were invading. It not only allows visitors to understand the size of the vehicles but also places the vehicles in the context of history.

The visitors of the Fort Bliss and Old Ironsides Museums in El Paso are people associated with Fort Bliss in some way or another. They may be soldiers themselves, spouses and children, or retirees from the military. Regardless of their association with Fort Bliss, they all have a connection. This connection is what allows the museums to touch the visitors and connect them to the past. Because the museums connect with and are related to the visitors, the visitors feel a mild connection to the history of the Fort but these museums pale in comparison to the El Paso Holocaust Museum and Study Center's efforts to connect visitors to the past.

The El Paso Holocaust Museum and Study Center connects visitors to this world event unlike any other. Going into this museum a visitor may wonder, how the museum will take a world event that occurred halfway around the world and connect to a border town in Texas? It seems like an unfeasible task yet this museum accomplishes it.

The El Paso Holocaust Museum and Study Center focuses itself around artifacts and relics from survivors who, after surviving the Holocaust, made their way to El Paso. The museum begins by telling the story of how Hitler came to power in Germany. It has visitors walk through a replica Jewish ghetto ending at a Star of David worn by a Jewish man who fled from Europe to America and ended up in El Paso (e.g. see fig. 3). There are also worn and dirty shoes that once belonged to survivors who came to reside in El Paso. These simple objects have a powerful impact on the visitor. The Holocaust no longer seems seventy years ago or halfway around the world; it has come to the backyard of the visitor. The visitor feels a deep connection with these items for they once belonged to a survivor who became an El Pasoian. (e.g. see fig. 4)

By connecting a world event to the border town of El Paso the museum has greatly enhanced its visitor experience.



Figure 3 A Star of David worn by a survivor of the Holocaust. This star is such a powerful image of the war and because it was worn by a survivor who moved to El Paso, its impact on the visitor is more substantial.



Figure 4 A replica boxcar that visitors must walk through to continue their tour of the museum. This boxcar places the history of the museum into context and brings this world event to the level of the visitor allowing them to connect to the history on a more personal level.

The visitor connects with the survivors on a much deeper and more personal level and because of this the visitor develops a more profound relationship with the history.

It would normally be safe to assume that a museum focused on a town's history would not be hard to connect to and in the case of The El Paso Museum of History, the assumption is correct; however, this museum somehow made it possible for people to connect on a much more intimate level with history. The traveling exhibit, *Neighborhoods and Shared Memories*, concerns the histories of the first two neighborhoods in El Paso (El Segundo Barrio and Chihuahuita). The museum chose to tell the histories of the neighborhoods through oral stories. Oral stories and oral history feature predominantly in Mexican culture so telling the histories of the oldest neighborhoods through oral stories was logical.

The exhibit featured beautiful floor to ceiling Mexican style murals painted along the walls (e.g. see fig. 5). At eye level there were digital picture frames with pictures of people living



Figure 5 A panoramic picture of the *Neighborhoods and Shared Memories* exhibit. The traditional folk art and emphasis on oral stories connects to the inhabitants (past and present) of these neighborhoods.

in El Segundo Barrio and Chihuahuita. It showed children playing, families gathering, and people working. Above the pictures were speech bubbles with brief memories and stories of the neighborhoods printed. There were few labels for the pictures and paintings but the minimalist approach gave people time to reflect on their memories of the neighborhoods. Although the labeling in the exhibit was scant, the museum provided a pamphlet that gave detailed descriptions of the pictures and paintings. By connecting people back to the tradition of oral history and story, the museum is able to draw close ties between the exhibit and its visitors.

Having an interesting subject matter is not the only important aspect of a museum that helps it be effective for visitors, the museum must also facilitate interactions between the museum and the visitor that are not superficial. Simply going to the museum and visiting is not engaging the visitor on a deeper level. According to Simon,

“Fostering deeper relationships offers obvious benefits to devoted visitors, who become more engaged in ways that connect to their intellectual and creative interests. It also serves the bottom line. If visitors perceive that an institution is personally responsive to their changing needs and interests, they are more likely to visit again, become members, renew their membership, and donate time and money to the institution.” (Simon 55)

When a museum engages the visitor in having them help create or add to an exhibit, the visitor is able to engage with the institution and develop a more profound relationship with it. The El Paso Museum of History again proves to be a superlative example.

In the Neighborhoods and Shared Memories exhibit, there is an area for people to share their own stories about the neighborhoods (e.g. see fig. 6). The visitor is invited to tell his or her own story and place it along side the stories of others. This continues the pattern of oral history and neighborhood connections. It also invites the visitor to help in the creation of the exhibit. Unfortunately, many people were not using this area, due to a lack of excitement within the community to contribute to the exhibit. The exhibit did, however, redeem itself. It was created in collaboration with about forty community members. These community members provided photos, stories, and time to make the exhibit come to life. The museum took the initiative to reach out to the community and invite them to aid in the construction of the exhibit. The extra pamphlet, provided with the exhibit, included the names of the members and gives them credit for helping create the exhibit. This collaboration between the museum and the community gives the community ownership of the exhibit and gives them the opportunity to interact with the museum on a deeper level.



Figure 6 A board in the Neighborhoods and Shared Memories where people can share their own stories about the neighborhoods. Even in this simple way the exhibit is encouraging the visitor to participate in the creation of the exhibit.

The El Paso Museum of Art also helps the visitor engage with the museum. Throughout the week the museum has art activities for children. Children can create artwork that is then displayed in the museum for other visitors to enjoy. The artwork ranges from crayon drawings, to 3D pottery sculptures. This activity provides the children with a chance to become published artists. They are able to take ownership of the museum and create their own gallery. This encourages the parents to bring their children back to the museum in order to create more pieces

of artwork. This tactic generates a reoccurring audience for the museum and allows the visitors to create the exhibit for themselves.

Along with the artwork the children can create, The El Paso Museum of Art also has a table set up where visitors can vote on what color the walls of the new exhibit should be (e.g. see fig. 7). The museum provides pieces of foam core board painted with the wall color options along with miniature prints of some of the pieces. The visitors can lay the miniature art pieces on the painted boards to see which color complements the artwork the best. They then can vote on sheets of paper. This is a simple yet effective way for the museum to engage the visitors in creating the exhibit. It is not as intimate as the Neighborhoods and Shared Memories exhibit; however it does engage the visitor with the museum on a deeper level.



Figure 7 A sign instructing visitors on how to vote for the new exhibit wall color. This simple gesture by the museum is encouraging visitors to become an active visitor of the museum and develop a deeper relationship with it.

Both The El Paso Museum of History and the El Paso Museum of Art allow the visitor to participate in the creation of the exhibits. This opportunity allows the museum to develop a deeper relationship with the visitor and helps them to establish the museum as their own. While both of these provide visitor a way to engage and connect with the museum, understanding what kind of objects are in the museum is also a vital part of a visitor orientated museum. The labels for the objects need to be geared towards the audience of the museum.

According to G. Brown Goode, exhibit labels need to be more than mere descriptions of the objects, the labels must give “its name and history so fully that all probable questions of the visitor are answered in advance” (Goode 431). The labels should provide visitors with the necessary information without overloading them with excessive scientific terms. The labels are for the visitors. They are not created for anyone else therefore they need to be something a visitor will read. The labels should be aimed at the common visitor of the museum. It is important not to “write different labels at different levels. Writing for different vocabulary or developmental levels – labels for kids, labels for adults – makes labels twice as hard to write, more expensive to produce, and it creates visual clutter in the exhibit... Children’s

museums are a special case. Labels for children’s exhibitions should be crafted for their developmental levels, not watered down to a childish version of an adult label.” (Serrell 96)

Labels allow the visitor to understand the exhibit and should be geared toward the respective audience of the museum. It is not necessary, however, to reduce the labels to a level that is below the average reading level of the visitor. If the museum is geared towards families write a label that is clear and concise and appropriate for the average family.

Children’s museums have a special challenge of creating labels that are for children. Children must be able to read and understand them with little to no difficulty; however, they should, as Goode asserts, still convey the necessary information and answer questions about the object or exhibit.

The San Antonio Children’s Museum does an excellent job of catering the labels to their audience. As the name indicates, The San Antonio Children’s Museum is geared towards children 12 and under and their parents. This being said, the labels are geared accordingly. The labels consist of a description of the exhibit that is written on a level that children seven to 12 can understand, followed by a description for parents on how to help their children engage with the exhibits (e.g. see fig. 8-9). These labels allow parents, who may feel that a museum is too academic for them to visit, the chance to feel comfortable taking their children to a museum. These labels are perfectly geared towards the museum’s audience.

Another example of labels that are aimed very well at the audience of the museum, is The El Paso Holocaust Museum and Study Center. El Paso is about 85% Hispanic

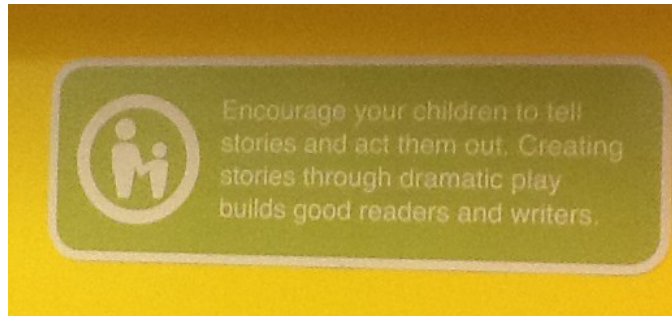


Figure 8 A label instructing parents on how to help their children interact with the exhibit. The San Antonio Children’s Museum does an excellent job of recognizing their visitor demographic and responding appropriately. This label is for the parents of children. It encourages the parent to engage their child with the exhibit.



Figure 9 A label with simple language geared towards children. This label was written for children. It is not a watered down adult label but rather a label that is simple enough for children yet still conveys the essential information about the exhibit.

and many people do not speak English well. The El Paso Holocaust Museum and Study Center has done a great job of accommodating this. All of their labels are bilingual and their videos (that are throughout the museum) are subtitled in Spanish. This museum has catered to the demographic of people visiting the museum and by doing so it is effective for visitors.

While I have identified three ways in which museums can strive to be more effective to their visitors, these are only examples, not a mold in which any museum can fit. In order for a museum to become effective for its visitors it must understand them. It must know what will connect with its visitors, what will encourage them to become a partner with the museum and participate on a deeper level, and what kind of language needs to be used on labels. If a set of rules a museum could follow to be effective existed, there would be no need for an analysis of aspects of museums that make them effective; however, there is not a mold and it is a trial and error process to develop a method through which a museum can be successful. It is only by understanding and catering to the demographic of visitors a museum has, that it can be effective. The museums discussed here are mere examples of this practice being put into place they are not forms in which any museum can be pressed into and an effective museum come out. Museums depend on their visitors for their existence; therefore, it is of vital necessity that a museum be effective for them.

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An English-language translation of Bocar N'Diayes's
Contribution à la connaissance des us et coutumes du Mali
(On the Habits and Customs of Mali)

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Abstract

On the Habits and Customs of Mali provides an overview of Malian traditions, customs and behaviors in the following fields: general etiquette, hospitality rules, marriage and the matrimonial process, birth and childhood, circumcision and excision, death and funerals, the inheritance process and body modification.

Translator's Notes

As a relatively inexperienced translator, working with *Contribution à la connaissance des us et coutumes du Mali* has proven to be a highly challenging experience. Not only is the process of translating the factual meaning of a text from one language into another language with different grammatical rules, idiomatic expressions and structural expectations very difficult, translating what lies beneath the text, so to speak, seems nearly impossible at times. For example, an author's use of a particular word instead of another suitable word can imply a subtle dislike or preference for the topic at hand. The use of colloquial versus formal language can show that an author intends his audience to be young adults or, in some cases, persons of a low social status. Certain terms that an author uses can disclose his background, age and educational level. There is also the difficulty of translating a word or idea from the source language when no comparable word exists in the target language. Should the translator attempt to explain the word or idea in a sentence within the text, add a footnote, or just use a word in the target language that has some sort of similar meaning?

In order to address these and other similar problems, the translator has adopted several techniques. First, she has employed a more informal, straightforward style in the translated text as compared with the highly formal, highly stylistic style employed in the original text. While formality may be appropriate for an educated Malian readership, the translator felt that using this style in an English-language edition of the text would make it sound foreign and somewhat antiquated. Second, the translator has condensed the text, mentioning only once in English what the author has mentioned two or more times in French, often within the same paragraph or sentence. The translator felt that an American audience would prefer a more concise version of the book. However, the translator has chosen to stay true to the seemingly “choppy” format of the original text. *On the Habits and Customs of Mali* is akin to an elongated and expanded version of the “know before you go” section in guidebooks, where authors treat one aspect of a country’s culture and then rapidly move on to the next. As the purpose of this book is to be an informational guide for tourists, expatriates and development professionals who are visiting or working in Mali, the translator felt that this format was appropriate. Another aspect of the text that the translator has tried to preserve is the occasional glimpses in the original edition of the author’s feelings about a topic. When a term is used in the French edition which seems to show the author’s disapproval of or support for an idea, the translator has chosen to employ a term in English which shows similar feeling. Lastly, the translator has added references at the end of the text which explain terms and concepts with which the reader may be unfamiliar, and which highlight the idea that certain terms marked in the text should not be equated with their usual meanings in English, but rather with the meaning provided in the reference section.

*A special note should be added on the use of *he* and *him* in the text. As in the English language, the French language often use the masculine pronouns *he*, *him*, and *his* to make gender-neutral generalizations, such as: *When someone gazes at the night sky, he can see the stars*. In addition, the French language frequently uses the pronoun *on* (roughly translated as *one*) to make context-dependent generalizations which may be either gender-specific or gender-neutral. There is no commonly-employed equivalent in Mali for *s/he* or *his/her*. The translator has chosen to use masculine pronouns whenever French masculine pronouns appear in the original text, or when the gender referred to is not clear.

On the Habits and Customs of Mali

Bocar N'Diaye

Translated by Heather Lee

Foreword

Faced with the continual decay of our traditional morals and young people's growing lack of knowledge of our cultural values, the Malian Association for Solidarity and the Promotion of Aged Persons (AMASPA) asked Mr. Bocar N'Diaye, a retired civil servant and former Malian ambassador, to organize a conference on socio-cultural organization (the caste system) and the traditional customs and behaviors of the Malian people.

The first part of the conference has been summarized in Mr. N'Diaye's book *The Castes of Mali*, which was recently reprinted by the publishing house Présence Africaine. AMASPA, worried about the preservation of certain aspects of our culture, requested Mr. N'Diaye to produce a book on the subject of the second part of the conference, the customs and traditional behaviors of the Malian people, so that it could be distributed to readers both in Mali and abroad. The present booklet represents the response to this request. It will allow current and future generations of Malians and foreigners to understand the culture of our country and appreciate our ancestors' behaviors and way of life.

AMASPA hopes that this booklet will accomplish these goals, although it does not pretend to exhaust a subject as wide and varied as the customs and traditional behaviors of the many regions and ethnic groups of Mali.

Introduction

Every country has its own customs and traditional behaviors which are nothing other than ways in which people conform to their culture and environment. The reader must keep in mind, however, that what appears to be a single custom practiced throughout the country is actually many different customs (practiced by different groups of peoples) that look the same on the outside.

It is easy to criticize African customs by comparing them to those from other cultures, but as these customs have been passed down through the centuries and generation after generation has accepted them, they must be beneficial to African's lives and relationships. According to one of our sayings, "We will do what our ancestors did and what our fathers have taught us. Our children must do the same." To totally reject the customs, traditions and behaviors inherited from our ancestors in favor of those of another country is equivalent to renouncing our own culture.

This is not to say that customs, traditions and behaviors must be left exactly as they are. We must adapt them to the way in which we live now without destroying their uniqueness. As one of our proverbs states, “You can eat the flesh and satisfy your hunger without touching the bone.” In other words, it could be beneficial to combine our good ancestral customs with external influences that meet the needs of modern life, but do not harm our own culture.

Now that we have spoken of African customs in general, we will successively examine practices concerning general etiquette, hospitality rules, marriage and the matrimonial process, birth and childhood, circumcision and excision, death and funerals, the inheritance process and body modification.

General etiquette

a) Greetings and polite behaviors

- Normally, a young person must be the first to share greetings when encountering a person older than himself.
- The respect that an individual feels for another is indicated by the length and number of handshakes offered. It is a sign of good upbringing to be the first to offer his hand in greeting.
- When an individual presents himself to a group of people, he must be the first to offer greetings, regardless of his age or social standing. The group returns his greeting, and then each individual acknowledges him by saying his last name.
- Each morning, all the members of a family must wash their bodies or their faces and then take turns greeting the family patriarch, who can usually be found seated in the courtyard or underneath a shade covering. The men bow to the patriarch and the women kneel or genuflect (bending one knee or touching it to the ground as a sign of respect) while saying good morning and wishing him a long life.
- A person must cede his seat to someone older than himself.
- An individual cannot walk in front of or next to a person older than himself unless he is invited to do so.
- A woman must cede her seat to a man.
- A woman must always walk behind a man when the two are together.

- For all questions concerning the life of the family, the husband must first consult his wife or wives before making a decision.
- When a woman encounters a man in the streets, she must be the first to offer greetings. If she is much older than him, however, it is the man that must first offer greetings by addressing her as *bacoro* (old mother)¹.
- When a young man must pass in front of a group of old people, he should remove his shoes so as not to raise any dust while passing by, as well as to show his respect for their old age. As soon as the young man reaches the group, he should greet its members.
- If a woman of any age must pass in front of a group of old people, she should not only remove her shoes but also genuflect in front the group and hide her face as a sign of humility and modesty.
- An individual of any age should leave his shoes at the door when entering a house or a sanctuary. Taking off one's hat is optional: wearing a hat inside, even in religious buildings, is not considered to be disrespectful.
- An individual is expected to show respect to his in-laws. In the past, he would go so far as refrain from eating in their presence. This tradition still exists among certain ethnic groups, notably the Peulh², who are distinguished by their legendary modesty.
- When a man encounters someone who is working, he must greet him by saying “*i ne ce*,” a contraction of “*i ne sègèn*” (you and fatigue) which means, “You have worked hard.”
-

b) Designations/Titles

Out of respect for age, it is customary to address any man who seems to be the same age as your father as “*N’fa*” (my father), any woman who seems to be the same age as your mother as “*N’ba*” (my mother), and anyone who seems younger than your mother or father but older than you as “*N’kòro*” (my older brother or sister). You should call an individual “*N’fa*” (plus his first name), “*N’ba*” (plus her first name) or “*N’kòro*” (plus his or her first name) when you are familiar with him or her.

c) Conversations

- In almost all ethnic groups, only the informal “you” is used in conversation. The formal “you” is not used³.
- When people find themselves in the presence of their elders, they must not speak unless invited to do so.
- An unmarried man cannot participate in the decision-making sessions of married men unless his presence is considered to be beneficial. When an unmarried man is present at the *arbre à palabres*⁴, he must leave when a problem concerning one of the families is posed to the elders and notables (aged persons who are recognized as being wise by the chief and the villagers).
- Young people risk being ostracized by their community if they curse or raise their voices in the presence of old people.
- It is not acceptable to openly contradict an elder. If an individual thinks an elder is wrong, he must say, “My father, you must be right because a man of your age, the wisdom of which cannot be wrong, never says something false; nevertheless it seems that things may have occurred differently.” After this, it is acceptable for the individual to give his own opinion.
- During a gathering, it is usually the youngest member who is invited to be the first to give his opinion on settling a matter. The second-youngest member shares his opinion next, and so on. After everyone has spoken, the oldest member summarizes everything that has been said and passes judgment on the matter. The judgment is rarely contested.

d) Meals

- Men and women eat separately, with boys sharing the meals of the men and girls sharing those of the women.
- When the woman of the house brings food to the men, she must kneel or at least genuflect while putting down the dish and saying, “Here is your meal.” Genuflection is equally appropriate when a woman gives a man something to drink or when she extends her hand or takes his hand in greeting.

- No one can touch a meal until the oldest man plunges his right hand into the container and invites the others to do the same⁵.
- During a meal, children must place their left hands palms-down on the edge of the container in order to keep it balanced and to show respect for their elders.
- Young people must never speak or look at the other diners while eating. They must keep their eyes on the contents of the container. Anyone who breaks these rules will not be allowed to finish his meal.
- Young people must not touch the pieces of meat that are grouped in the middle of the dish. They must wait until the head of the family places some in front of them.
- It is common to leave the last of the dish to the youngest diners, because their small hands prevent them from eating as much as the adults.
- At the beginning and end of a meal, the diners use the same container to wash their hands. The oldest is the first to wash and the youngest is the last. When a drink is served after the meal, the same order applies. The oldest rinses his mouth and drinks from the pot first, after which he hands it to the second-oldest, and so on. Next, each diner addresses the head of the family, saying “*a barika*”(Thank you), to which he responds “*a barika allaye*” (Thanks to God). Then, addressing the woman who cooked the meal, he says “*ini goua*” (The meal was delicious), to which she responds with either “*gouatigui ye allaye*” (It is God who is the master of kitchen) or “*goua ma diya*” (The meal was not very good). He then says “*a diyara yerede*” (It was delicious).
- Belching is a sign that one has enjoyed a meal and is satisfied. On the other hand, farting in public is very impolite, especially among the Peulh.
- Before a farmer eats in his field, he should throw a pinch of his meal over his left and then over his right shoulder while saying, “Here is your portion.” If the farmer is going to drink any water, he should pour a small amount on the ground while repeating the same phrase. In this way, he wins the good graces of the nearby terrestrial spirits by offering them a symbolic portion of his food and drink. It is also wise to avoid throwing pebbles in the fields, unless one has a good reason for doing so. These pebbles could hit the *djinns*⁶ who are believed to inhabit these places and who could punish the person who threw them.

e) Other rules of politeness

- Being the first to offer tobacco or cola nuts⁷ when encountering a friend or acquaintance in the streets is a sign of good upbringing.
- As it is unacceptable to walk in front of or next to an older person without an invitation, an individual should adjust his walking speed to meet that of an older person walking in front him.
- It is polite for a young person to stop and move off to the side of a path in order to let an old person pass by. The old person should then bless the youth to thank him for his thoughtfulness.
- Spitting when encountering someone in the street can be considered a sign of contempt, so a young person should abstain from spitting in the presence of an old person. However, a young person *should* spit if he has tobacco or cola nut residue in his mouth, as it is very impolite to speak with a full mouth.
- When something is shared between people of the same social status, it is the youngest who chooses first, then the next-youngest, and so on. The same choosing order applies when a polygamous man gives something to his first wife to share with her co-wives. The newest wife chooses first, and the first wife chooses last.
- It is customary to accompany a visitor to the street when he is leaving the house, as this is a sign of friendship. In certain ethnic groups, a host should walk in front of his guest as he is leaving. This custom results from the fact that in the past, the powerful members of certain ethnic groups would walk behind an undesirable visitor as he was leaving, thus signaling their bodyguards to kill him. The tradition of preceding your visitor to the door is still practiced today, even in the urban areas. Do not be surprised or offended if your hosts walk in front of you as you are leaving. Remember where this tradition came from, and consider it a sign of friendship.

There was a time when young people perfectly followed these customs and rules, not only because they were handed down by their ancestors, but also because they were assured that they would be treated in the same manner when they reached old age.

Hospitality Rules

The rules of hospitality are sacred in Mali.

For Malians, a stranger has the right to be treated as a guest of honor, as strangers are sent by God. Strangers have the right to the help and protection of their hosts. In other words, anyone who welcomes a stranger into his house should defend him, regardless of the circumstances which drove him to seek refuge. In the past, wars broke out between two villages, sometimes even two kingdoms, when one of them refused to extradite a criminal who had been accorded asylum there. This was the cause of the war which broke out between the Toucouleurs⁸ and the Macinanké⁹. After the Bamanan king of Ségou was defeated by the Toucouleurs (led by the Foutanké conqueror El Hadj Cheik Oumar Tall¹⁰), he took refuge with the king of the Macinanké. The king refused to deliver his asylum-seeker to the Toucouleurs, thus starting the war.

When a stranger arrives at a household, he is welcomed joyously, shown to the most comfortable seat and given something to drink. The women immediately prepare water for his bath, and all the members of the family and their neighbors come in turn to greet him. The host then presents his guest with a welcome gift according to the guest's importance or the host's means, such as an ox, a steer, a male goat, or one or more chickens that will be immediately slaughtered. Afterward, the guest is shown the location of his room and the bathroom. Finally, the women will bring heated water to the bathroom for his bath.

When a distinguished guest is present, all meals will be consumed in the hut which has been assigned to him. The head of the house will transmit his rights to the guest. For example, he will be the first to wash his hands before mealtimes, plunge his right hand in the container and drink and wash his hands afterward. After mealtimes, those present will thank the guest, rather than the person who provided the food. The rules of hospitality are such that when a stranger presents himself at mealtime, he must be invited to share the meal. In order to avoid offending the stranger or interfering with his appetite, no one may ask him any questions before he has eaten. It is only at the end of the meal that he is asked his personal information, such as his first and last names, his origin, and the reason for his visit. He is then given a hut in which to rest if he is just passing through. If he is going to remain in the area, no one will ever ask him how long he is planning to stay. The stranger can stay a day, a month, even a year, which is of little

importance because no one will ask him to pay. Every stranger that is housed has the right to free room and board no matter how long his stay or the means of the host family.

The Malian people are legendary for their hospitality, but they are also known for their great tolerance toward strangers. Their morals and behaviors, bizarre as they might be, bring no obvious surprise or reprobation. It would be logical for these strangers to act the same toward others, all peoples having their own specific customs and behaviors.

In conclusion, a Malian who receives a stranger into his home tries to ensure that he is comfortable, lacks nothing, and will have good memories of his stay when he leaves. The majority of hospitality traditions are still alive. In both the large cities and the countryside, it is extremely rare for a stranger not to be welcomed when he knocks on a door.

Human Relationships

One of our proverbs, turned into a popular song, teaches us that “a society in which conflict reigns will be destroyed.”

Our ancestors lived by many rules regarding social order and human relationships, of which forgiveness played a large part. No harmony can exist between individuals without forgiveness. Human nature being what it is, however, it is impossible to avoid arguments between people sharing the same households, workplaces, and recreation areas. These arguments should be dealt with immediately to prevent the situation from worsening. This is why custom requires that one of the perpetrators make an effort to ask the victim for forgiveness while a third party, most often a *nyamakala*¹¹, usually intervenes to reconcile them.

At the suggestion of the *nyamakala*, the youngest person involved in the dispute usually apologizes first and extends his hand to his elder, after which the elder is then obliged to apologize in turn. If the conflict is between a couple, it is usually the wife who apologizes and extends her hand to her husband first, unless the husband has committed a serious offense, such as infidelity. In this case, he extends his hand to his wife while asking for her forgiveness, promising to never again commit the same offense. Occasionally, these reconciliations will end with a small ceremony which consists of pouring some water on the ground to symbolically prove that the “fire” burning between the two parties has been extinguished. It is extremely rare for a reconciliation attempt to fail, especially one initiated by a *nyamakala*.

In certain ethnic groups, an individual can apologize by kneeling or laying stomach-down in front of the person he has wronged, placing his arms on his back, and pleading for forgiveness by saying *yafama* (for a Bamanan¹²), *yafommi* (for a Peulh), or *yafingah* (for a Soninké¹³), which means, “Forgive me.” This method is used when the person who has been wronged is the individual’s elder or superior. It can also be used when an individual wishes to end a dispute. In either case, the person who has been offered the apology must stand and help the repentant person to his feet, assuring him that he has been forgiven.

One of the fundamental principles of Malian society is forgiveness, because a lengthy quarrel between two people can lead to fighting between their families, which can in turn lead to fighting between the two clans to which their families belong. For example, two clans in the Diawara¹⁴ community fought with one another for several centuries following a quarrel between two of their young boys who fancied the same girl. The community is still suffering from the aftermath of this conflict. This example further demonstrates the necessity of resolving all disputes as soon as possible, before they lead to a collective catastrophe.

In Mali, strangers do not remain strangers for long. As soon as an individual finds himself in the presence of a stranger, he quickly strikes up a conversation. He first extends his hand and asks the stranger’s family name, which he repeats as a sign of respect. He then asks him about his origins, the state of his and his family’s health, the state of his friends’ health, etc. Next, he introduces himself to the stranger, who repeats his family name. Before long, the ice has been broken between the two individuals, and they start acting like old friends. This is why the majority of Malians who visit Europe for the first time are surprised when they see that people on the street and in buses rarely greet or even look at one another. If you are in Mali, do not be surprised if a stranger spontaneously speaks to you. If you do not wish to have a conversation, you should at least smile at him. It would be considered very rude if you ignored him completely.

When moving into a new house in an urban area, it is customary for an individual to pay a courtesy visit to all of his close neighbors. This will ensure an atmosphere of friendliness and solidarity. It is important for a person to create and maintain good relationships with his neighbors, because they will be the first people he turns to in the case of misfortune.

When moving to a small village, an individual must seek approval to stay in the village from the chief, the imam, the traditional animist priest (if there is one) and the prominent villagers. He must also pay a visit to his new neighbors, accompanied by the leader of the *griots*.

There exists a particular custom which is very important in Malian social life, called *senenkouya* (joking cousins). *Senenkouya* is an alliance between certain villages, ethnic groups, and lineages. Members of a *senenkouya* alliance trust one another, help each other in all circumstances, and jokingly insult each other. *Senenkou* recognize each other by their last names. For example, a Diarra is the *senenkou* of a Traoré.

If an individual's *senenkou* (joking cousin) is angry, he can simply evoke the age-old alliance which unites them and his anger will cease. An individual can even influence the decisions that his *senenkou* makes. In the past, the *senenkou* of a king could prevent him from executing one of his subjects or declaring war if his reason to do so was unjust. However, the *senenkou* could not interfere when the king was acting in his own defense or preserving the honor of his kingdom.

As has been shown, the link between two *senenkou* is very strong. In certain cases, the testimony of an individual's *senenkou* is not accepted, because everyone knows that two *senenkou* will lie for each other.

There is another traditional alliance called *dioo*, which is widely practiced by the Bamanan. It differs from *senenkou* in two respects. First, *senenkou* is an eternal practice which was handed down by the ancestors, while *dioo* can be arranged at any time and does not usually endure beyond the deaths of the two who concluded it. Second, *senenkou* is a collective alliance, while *dioo* is usually concluded between two people who bind themselves together by a sacred pact. To make this pact, the individuals first fill a calabash with goat's milk. Next, they cut themselves lightly on the left arm and pour several drops of their blood into the milk. They then stir the milk, and each one of them holds one side of the calabash as they take the oath to become united by the *dioo*, swearing on the heads of their ancestors to help each other in all circumstances, even at the cost of their lives, to never purposefully hurt each other in any way, to never spill the other's blood and to always defend each other. Next, they drink all of the milk in the calabash and pull it apart when they are finished, each one stomping on his half of the

calabash. Finally, each one solemnly vows “that I will be broken into pieces as we have just done to this calabash if I fail to uphold the oath I have just taken.”

Sometimes a *dioo* will be passed to the next generation, but this is not required, as the oath only affects those who voluntarily concluded it. Nevertheless, some people attach such importance to *dioo* that a descendant of one of the oath-takers will not marry a young virgin belonging to the same lineage as the other oath-taker, for fear of spilling her virginal blood.

The totem and community associations

The totemic system exists in Mali. In some countries, many ethnic or tribal groups believe that a certain animal is their mythical ancestor or distant relative. In Mali, certain social groups consider a particular animal to be an ally, because that animal helped them out of a difficult situation in the past. After this fortunate event occurred, the patriarch of the group made its members swear to never harm the animal and to transmit this prohibition from generation to generation until the end of time. This is why the descendants of the group will never hunt the animal or eat its flesh. If they encounter one of these animals that is wounded, they must place their finger in the blood flowing from its wounds and mark their forehead to symbolically signify that they share the animal’s suffering. They then heal the animal if possible.

Mutual aid is another important aspect of Malian culture. During the rainy season, for example, it is customary for young boys and girls, assisted by tam-tam players, to arrive unannounced at a family’s field and work there the entire day for free. The family will prepare a large banquet for them as a sign of thanks. Later on in the season, children also help with harvesting and grain threshing. Usually, free labor of this type, referred to as *sokhankhayé* by the Sarakolé, is carried out by the traditional associations of certain regions or ethnic groups.

Traditional associations, called age classes or age groups, are principally composed of men who have been circumcised together. Associations bind their members together for life. They are called *flanbolo* (age group) or *ton* (association) by the Bamanan, *waldé* by the Peulh, *fédédé* by the Toucouleur, etc. These associations still exist in rural areas.

An association is generally headed by a president elected for life by all the members. He is assisted by a *kankorossigu* (assistant), a treasurer and a *tondiéli* (*griot*/herald of the association). The *griot* (always a *nyamakala*) is the driving force of the association. He acts as a

messenger between the president and the members, organizes and conducts group meetings, represents the group to other associations, resolves conflicts between members, etc.

Associations are well-structured and governed by rules which no member would consciously break. When an association is created, each member swears on the Holy Quran, their ancestors or their word of honor to respect the rules in all circumstances. In the case of misconduct, the guilty member has the right to defend himself during a general assembly before being sanctioned by the president. Sanctions can include a warning, a fine, expulsion from the association, etc. A *nyamakala* must not be fined, because *nyamakala* should not be forced to give money to nobles. Instead, he can be given a punishment that is quite harmless but very unpleasant. This consists of making him consume a large quantity of food and drink. The grimaces he makes when his stomach is overstuffed amuse everyone watching the spectacle. A *nyamakala* is also never expelled from the group, no matter what he has done, because this would harm the association. First, the association would be deprived of an element essential to its proper functioning. Second, everyone belonging to the *nyamakala*'s group would defend him and would spread vicious rumors about the association's members. A *nyamakala* is a necessary evil, so to speak.

Women can create traditional associations as well, but these are not as structured or regulated as the men's associations. This is because marriage and multiple domestic duties do not allow women a lot of free time to devote to the group. Women's associations only convene to play tam-tam drums in celebration of the marriage of one of their members. A woman's association ceases to exist when all of its members have married.

Finally, it must be noted that associations such as the ones described above still exist in rural areas. Drawing on the traditional functions and organizational structures of these associations, an attempt was made during the Second Republic's fight for (food) self-sufficiency to modernize them under the name of *ton villageois*.

The rules and customs that we have discussed in the preceding three sections allow for harmonious interaction between members of a group or community. Violation of these rules brings only a moral sanction and shunning by community members, which is much worse than any physical punishment.

Marriage and the marital system

a) General information

This section does not cover all the various requirements which must be completed before a marriage takes place, nor does it provide detailed information on marriage ceremonies. Rather, it describes certain principles that govern marriage and married life.

In the past, a marriage could take place between a man of high status and a woman of low status, but not between a man of low status and a woman of high status. For example, a nobleman could marry a female *nyamakala*, which traditional chiefs would often do, especially when the oracles prescribed it. It was said that a female *griot* or slave (a person of low status who acted as a laborer or domestic, often part of a slave family who had served the same family for generations) could bring happiness to a chief. In the same way, a male *nyamakala* could marry a female slave. On the other hand, a male *nyamakala* could not marry a female noble, and a male slave could marry neither a noblewoman nor a female *nyamakala*.

In certain ethnic groups, couples that flouted these rules were excluded from their communities, and the ostracism which they felt became so great that they either exiled themselves or divorced. Such mismatched marriages are becoming more and more frequent however, more so in the urban areas than in the countryside where certain ancient taboos are still strong.

The joking cousin relationship forbade any marital alliances between certain ethnic groups. For example, a noble Peulh and a blacksmith could not marry one another. This taboo is still largely respected, because it is fully believed that such a union will bring misfortune to the couple or its descendants.

There is also the case, among others, of the group of Bamanan Massassi¹⁶ nobles. A Massassi nobleman could not marry a Massassi noblewoman. It was necessary for him to take a wife from a different ethnic group. This prohibition is still scrupulously observed.

After a master marries his slave, she is called *tara*. The woman has the right to receive her husband only on Monday and Friday nights, the other nights belonging to her noble co-wife. A slave-wife can become emancipated after she has born children to her husband. These children are considered as being completely noble (they can advance to the highest offices in the

hierarchy of nobles, and even become kings), because in our traditions women are like the earth: when a developed seed is planted in them, it is only this exact seed that comes into the world. In other words, the slave-wife has only served as a means of fertilization of the noble sperm that her master has deposited in her. Because of this principle, children in most ethnic groups return to their father in the case of divorce.

In certain regions, wife-beating is not directly prohibited. A husband may not beat his wife with his hands, but only with a whip, which is less dangerous and less painful for the woman. This is why a symbolic whip is added to the trousseau, which means: "If it happens that you want to hit your wife because she has committed a fault which merits it, do it with an ordinary whip and not with your hands, and especially not with a "long-tongued whip." Under pain of divorce, it is not permitted to insult one's wife or, more importantly, her ancestors through an undeserved beating.

This custom is practiced less and less, but it has not totally disappeared in certain regions. It must not be inferred from the possibility offered to a husband to beat his wife that he has the right to do so for any reason. The application of this possibility is subject to certain conditions.

There is an Arab proverb which says, "Beat your wife each morning; if you don't know why you hit her, she herself knows." Our proverb says, "A wife does things everyday which merit being beaten, but you will only beat her when she has done something which would merit being killed." In other words, in order for a husband to hit his wife, she must have committed a very heinous act. Mistreating her because of a petty act or for a reason that is not legitimately sanctioned by custom is considered grounds for divorce. In sum, custom demands that husbands be as tolerant as possible regarding their wives and recommends that they overlook certain defaults inherent in their nature.

Women in most ethnic groups are not allowed at public reunions during which important problems concerning the life of the town or village are discussed. However, it is permitted for women to suggest solutions to these problems through "pillow talk." Women frequently resolve problems in this manner, their husbands acting as intermediaries. It is therefore a mistake to say that the black woman plays no role in the political life of her country. In effect, it is not important that she play an official role in politics, because she often influences the decisions that men make in this domain.

b) Engagement, marriage ceremonies and married life

Customs concerning marriage differ from one religion to another and sometimes even from one ethnic group to another. On the whole, it is possible to (over)simplify them as follows.

Generally, the engagement is done discreetly. This discretion is little by little coming under attack in certain towns and cities, notably in Bamako, where the families of the fiancés sometimes organize a drum party to celebrate the engagement. The engaged man's sisters and their friends may dress up in their prettiest attire and go to greet the family of the future wife, accompanied by women *griots* singing their praises. Traditionally, the future husband and wife must avoid each other before their marriage. When a man goes to visit his future in-laws, his fiancée must hide herself.

In some ethnic groups, a young woman can marry before puberty. In this case, she is welcomed into her family of in-laws and into her husband's house, but he must only touch her when she has attained puberty (the appearance of breasts and the beginning of menstruation).

Among Muslims, it is strictly forbidden for a man to marry a pregnant woman. Before a marriage can take place, the *marabout*¹⁵ in charge of officiating the union must be assured by the future wife's parents that she is "clean" (not pregnant). He must then ask for the names of the husband's and wife's witnesses and "virtue guarantors." He will then pronounce the appropriate prayers to unite the couple for the best and for the worst.

A Muslim boy can marry a girl of another religion if he has the intention to use his influence to convert her to Islam. On the other hand, a young Muslim girl is not permitted to marry a boy of a different religion, because he is liable to lead her to renounce her religion.

Until their marriage, boys and girls were considered minors, no matter their ages. Parents chose their son's first wife and their daughter's first husband without consulting them. Once married, they became adults. A man could then choose his additional wives if he desired to be polygamous, and a divorced or widowed woman could freely choose her next husband.

Marriage is considered to be a social contract between two families. The woman is not an acting party in the contract (she is only the object of the contract). Her consent is therefore not traditionally demanded. Marriage is in some ways a transfer of ownership of the woman, who passes from the hands of the head of her family to those of the head of her spouse's family.

Certain ethnic groups do not view marriage in this manner. Among the Bobo¹⁷, for example, an engagement can result from a direct agreement between young people who have attained puberty, with or without the previous consent of their parents (though the parents will still have to agree to the marriage). Parents may also agree, right after the birth of their children or during their infancy, to marry them to one another in the future.

Among the Touaregs, boys and girls can engage in sexual relations during a sort of “love assembly” called *Tahal* that takes place during the night under a special tent put up for the occasion. Boys of marriage age and young pubescent girls take part in *Tahal*, and meetings between young lovers continue until nuptials. Married men and women whose spouses are absent can also participate in *Tahal*.

When parents choose a future spouse for their child, the head of the family, assisted by the village sages and *griots*, ensures the worthiness of the boy, and especially that of the girl, as well as the respectability of his or her parents.

When a young girl is chosen as a future wife, the head of the boy’s family holds a family meeting during which he designates someone, usually the boy’s youngest uncle, to consult a *marabout* or a fetishist (“knower of hidden things”). The *marabout* or fetishist will then consult an oracle to make sure that the future wife will not bring misfortune to her future husband or his family. The parents of the young girl will also consult the oracles to know if the proposed union will be prosperous or not. However, we insist much less on the parents of the future wife consulting the oracles, because it is believed that the happiness or misfortune of a marriage depends more on the beneficial or harmful influences that come from the wife than those that come from the husband.

In addition to sending someone to consult the *marabout* or fetishist, the head of the boy’s family will send another family member, or the family *griot*, to observe the future wife’s habitual actions. These behaviors will reveal her nature and allow him to foresee what the marriage will be like. He will be able to know if she is a *téredigou* (Bamanan) or a *kitado* (Toucouleur), which means bringer of misfortune.

The following is a list of some behaviors that indicate that a girl is a *téredigou*:

- A young girl who has flat feet and leaves full footprints, packing down the ground as she walks, is said to be leveling out the grave of her husband. She is thought to have

“devoured” three previous husbands but will spare the fourth if a suitor dares to ask her hand. We call her *sengourou saba sigui mouso* (the woman who has been a widow three times).

- A young girl who lengthens her neck to the front while walking, giving the impression that she is stretching out to observe something in front of her, is thought to be looking into the grave of her husband. We call her *kabourou kono flé mouso* (she who looks inside the grave of her husband).
- A young girl who enters a house with her right foot and leaves with her left will bring good fortune and happiness to her husband’s house and leave this happiness there in the case of divorce or her husband’s death. If, on the contrary, she enters with her left foot and leaves with her right foot, she will bring misfortune to the conjugal house and will leave this misfortune behind if she leaves the household.
- A young girl whose feet tilt toward one another while walking will bring wealth to her husband’s household. A young girl whose toes move away from each other as if they are rejecting something while walking will cause her husband’s household wealth to be lost and will keep further fortune away.
- A young girl who starts with her right leg when lifting her legs will be happy in the conjugal house, while a girl who starts with her left leg will be unhappy.

It must be noted that these valuations are not even remotely esoteric. They result from corresponding observations made across the centuries which were then adopted as a method for choosing a wife.

Sometimes parents wear themselves out trying to teach their daughters how to behave properly so that they may become wives. Certain girls end up without a husband because human nature proves to be very strong in them, to the point that they instinctively act contrary to their parents’ teachings. For example, can we make a left-handed person become right-handed simply because her parents demand it? You might as well ask a one-armed person to grab something with his stump.

It is extremely difficult for a woman who has been widowed twice to find a third husband, because, as the proverb says, there is “never two without three.” However, a suitor can

fight against the *djinn* spouse of the unlucky woman through certain spells cast by a *marabout* or fetishist. Every woman is believed to have an invisible husband which can be either kind or mean towards her human husband. The *djinn* spouse of a woman who has been married twice is thought to have killed his rival human husbands out of jealousy.

Like a woman who has “killed” two spouses, a man who has been a widower two times will also have difficulty finding a third spouse. But it is easier to “treat” a man than a woman in this area because a man does not have a *djinn* wife to fight. Rather, he is the victim of a bad curse which most fetishists can easily break thanks to the occult powers which they are thought to possess. Upon the death of his first wife, a widower may ask these sorcerers to ward off the curse in preparation for his second marriage.

Polygamy

Polygamy is part of our customary practices. For some, polygamy is explained by the desire to have many hands to work the fields. In this case, the number of wives a man has will depend on his means. For others, polygamy allows a man to overcome the unavailability of one of his wives during her period or time of child labor. It also allows a man to procreate in the case where one of his wives is sterile, because in Africa it is very unfortunate not to have children.

In the past, a man could have an unlimited number of wives. Affluent men sometimes married a dozen women, if not more. After the arrival of Islam, the maximum number of noblewomen that a man could marry was limited to four.

Until recently, some animists did not abide by the four wives rule as determined by Islam. The state had to intervene by introducing the marriage code and laws to prevent them from exceeding this number.

Both Muslims and animists were permitted to live with an unlimited number of female slaves. After the disappearance of slavery, this system disappeared as well. Among the Touaregs, however, relationships with female servants are tolerated, though monogamy is the rule.

It must be noted that for varied reasons, notably economic constraints, polygamy is little by little giving way to monogamy. This is especially true in the large urban areas.

Some polygamists have a rotating cycle in which they spend one night with each of their wives. The majority, however, spend two nights in a row with each of them. Other polygamists

have their own room where each wife comes in turn to join him. Islam urges men to treat their wives with equity.

The major drawback of the polygamous system is the discord that permanently reigns between co-wives when they live under the same roof. This makes their husband's life miserable and damages relations between their children, especially after their father dies and the time comes for the division of the inheritance. This is why certain wealthy men prefer to house their wives separately from one another.

In certain ethnic groups, the proof that a young girl was a virgin on the day of her first marriage will remain important for the rest of her life. The day after the consummation of her marriage, her stained white *pagne* (undergarment) bearing witness to her virginity is paraded through the village to the beat of drums, accompanied by singers and dancers. .

A woman who was a virgin bride is respected by both men and women, and she also has some authority over her husband when he throws a jealous fit. In this case, she will remind him of the pure state in which he found her on the first night of their union, to show him that he has no right to doubt her chastity. On the other hand, it is the husband who will remind his wife that he found her as "open" as her mother (someone who is obviously not a virgin), and that she has no right to protest when he reproaches her for any reason. He will accuse her of not being able to keep her *pagne* on when she sees a male.

Poverty does not prevent a girl from finding a husband. It is only necessary for her to be pretty and have the reputation of being hard-working and well-educated.

It is strictly forbidden for a man to be married to two sisters at the same time. If his wife dies, however, he may marry her sister.

A dowry, paid by the husband and belonging to the wife, is obligatory among Muslims. A marriage is not valid until the dowry has been partially or totally paid. In the case of partial payment, a time limit for payment of the balance will be fixed.

A dowry can be paid in money or animals. Even in the second case, the husband will pay at least a quarter of a dinar (*roubouhou-dinar*). In Mali, a quarter of a dinar corresponds to the price of a gram of gold. The sum of the dowry varies among ethnic groups. Among the Peulh and the Diawambé, the dowry can be equivalent to at least a dozen cattle, and among the Touareg this number is even more elevated.

Current legislation has fixed the dowry sum at 10,000 F CFA¹⁸, but this rule is bypassed by offering customary gifts, so that the sum varies according to the future spouse's resources. The average worth of these gifts is 100,000 F CFA with the addition of a basket of cola nuts, both of which are shared between the "mothers" (the future wife's mother, her female relatives, and her friends).

A dowry is not paid among the animists when girl-swapping occurs. A swap occurs when two family heads exchange daughters in order to gain wives for their sons. This practice, though uncommon, is justified by the fact that women are a part of the family capital, so there is a loss for the family who gives a daughter in marriage and a gain for the family that receives her, unless the daughter's family receives just compensation. The compensatory swap creates equilibrium between the two families.

Divorce is allowed in both the animist and Muslim communities. In the case where the wife divorces the husband, she must return her dowry and the customary gifts. The husband can also take back the clothing and jewelry that he had given her. When the husband divorces the wife, he does not have to pay her anything, but he must let her keep all her personal effects, including the clothing and jewelry that he had given her.

Ex-spouses can remarry, but if the husband pronounces the word *haram* three times while divorcing his wife, Islamic law states that he cannot usually remarry her until she has married and been divorced from or widowed by another man. However, if the husband says to his wife "I make you wear the underclothes of my mother," he can never, in any case, remarry her, because he would be committing incest: all sexual relations he has with his ex-wife are equivalent to sexual relations with his mother. The same idea applies if the wife says to her husband "I make you wear my father's pants."

In the Touareg community, the wife plays an important role. In fact, divorce is generally instigated by the wife. There are many reasons a wife may want a divorce, including the desire to regain the liberty that she regrets having lost after her marriage. Divorce takes place through mutual consent of the spouses. If the divorce was brought about by the wife, she may have to return her dowry to her ex-husband and leave the children with him.

Among Muslims, a divorced woman can only remarry three months after the divorce, even if the spouses had not slept together for several months or even years. No such delay is imposed by the animists.

Custom demands that a wife be completely submissive to her husband, because a wife who is not submissive will only give birth to children who misbehave. A proverb of ours says, “A child who is told by his mother ‘stay there until I have finished with your father’ will be inferior to other children.” In other words, a child will achieve nothing in life if his mother is not submissive to his father. We also have a proverb that says that the child of a docile wife will always surpass the child of a non-submissive wife, and that while the first child will be able to deal with certain situations with ease, the second child will founder.

A child who hits his parents will not only be beaten publicly by the community, but also never achieve anything in life. Such conduct is considered to be a sign of moral decay, which will usually lead to the banishment of the individual. It is believed that the mother is responsible for the child’s misbehavior, because she herself must have behaved badly toward her husband. As a result of this belief, the father of the banished child will normally divorce the child’s mother.

Out of respect for her husband, a wife must not call him by his first name. She must call him by some sort of surname, such as “father of (name of eldest son),” *sotigui* (head of the family), *Ladji* (El hadj) if he has made the pilgrimage to Mecca¹⁹, etc.

It must be noted that polyandry, which allows a women to have several husbands at the same time, is not practiced in Mali.

Remember that tradition teaches us that a woman is controlled by her parents when she is young, her husband when she is married, and her children when she is old.

Birth and childhood

In Mali, the birth of a child is considered by some to be a gift from Allah and by others to be a blessing from the ancestors and occult powers. A child’s arrival in the world is celebrated by a large, joyous gathering in which all the inhabitants of the village or neighborhood take part, whether the parents are animists or Muslims, rich or poor. Neighbors and friends near and far

come to visit the family, and, according to tradition, pass the newborn from one another in order to bless it. Sometimes gifts are brought to the young mother.

Among the Bamanan, a baby boy must be called *tiédiè* (white man) because all children born of black parents are born white and do not start to turn black until several days later. A baby girl is called *moussokoura* (new woman). These names are used until the child is baptized.

When delivery is difficult, the older women in charge of assisting and aiding the pregnant woman ask the husband to remove the cord which holds up his pants in order to facilitate the delivery. It is thought that the tighter the husband's pants are, the more difficult the delivery will be. It is a very old belief which is still practiced by some ethnic groups.

Among the Muslims, baptism takes place on the eighth day after birth, accompanied by festivities, the manner and type of which depend on the means of the new parents. On the day of the baptism, the ceremony is held early in the morning for the men and in the afternoon for the women. A sheep is always sacrificed for the occasion. If the father cannot afford to buy a sheep, he can ask for help from wealthier people, because it would be shameful for him to not be able to sacrifice an ovine. When a father must ask for help, he will often be given more than is needed to buy the animal.

Everyone present contributes to the costs of the ceremony according to their means or their relationship to the parents. The money that is collected is shared between the *marabouts* in charge of baptizing the child and the *nyamakala* (*griots*, *finah* (mimes) and cobblers). Cola nuts are distributed to everyone at the ceremony.

The baby is shaved by its sister or a cousin of its father. Its hair is given to the mother to either keep or bury according to the ethnic group to which the couple belongs. In the animist community, the baby is occasionally not shaved. He will keep the hair he was born with until his death. He will glorify his hair, and when he must swear or take an oath he will say, "If it is true that the hairs which cover my head are those that I was born with, I swear that..."

Generally, a boy is given the name of his grandfather and a girl is given the name of her grandmother. Out of respect for their own parents, new parents will nickname their child *N'fatokoma* (namesake of my father) or *Batokoma* or *N'batokoma* (namesake of my mother). Among the Muslims, the child can be baptized with a name from a book containing the names of Islamic saints, or with the name of a friend of the father or mother. Among the Toucouleur, the

father will name the child and the mother will usually give the child an additional first name. Generally, this name will take the place of the name under which the child was blessed by the *marabouts*, because the mother, who is in permanent contact with the child until he or she is around seven years old, will use this name. Eventually, everyone else will use the name as well.

There are “standard” names given to children according to their order of birth. In the Peulh and Toucouleur communities, the first boy is named Hamady, the second Samba, the third Demba, and the fourth Yéro. The name of the first girl is Sira, the second Coumba, the third Penda, the fourth Tako, etc. Names of this type can also be found in other ethnic groups, such as the Bamanan.

In the Muslim community, the first names of two male twins are usually Al Hassan (which becomes Lassinè or Lassana or even Siné in common usage) and Al Housseyne (which becomes Housseyne or Sèye in common usage). The names of two female twins are Adam, Adama or Damou and Hawa, which means Adam and Eve. If the twins are a boy-girl pair, the name of the boy will be Adam or Adama (this name is used for both boys and girls) and the name of the girl will be Hawa. In certain ethnic groups, the eldest twin is named Sadio. This name is used for both sexes.

It should also be noted that first names can relate to the day or month during which the child was born. Such names can include Alkamisa (Peulh) or Alamissa (Bamanan), which means Thursday, Aldiouma, which means Friday, and Korka (Peulh) or Soungalo (Bamanan), which means the month of Ramadan²⁰.

A family that has lost their first children will give silly names to their other children in order to drive away the curse. For example, the following first names are given in the Bamanan and Malinké communities: Filifing or Fily (to throw), Kounandy (lucky), Nakounté (one who has not come), Noumouké (blacksmith), Nagnouma (welcome), etc. In the Peulh community, the following first names are given: Guédado or Guéda-n’guel (she or he that one likes) Dioddo (the pretty one), etc. In the Soninké community, Sédinté (thrown) or Sédiho (to throw) are used.

If a couple has been without children for a long time, the child that marks the end of this “dry spell” will be given a silly first name. For example, among the Soninké, the child will be named Dalamané (the one who stayed a long time with its mother).

Some children can have the fore-mentioned names without having been named for the stated reasons. These children have been named after their grandparents, who received their names for these reasons.

Children are usually raised by their grandparents, which has two great advantages. First, the children are raised in the same manner as their parents were. Second, the parents are freed from the time-consuming task of child-rearing, and they are able to concentrate on their normal occupations.

In the majority of ethnic groups, children are breastfed by their mother until weaning. In the case of conflict between two men, one can say to the other: "If you confront me, you will know at your expense that I was filled with the milk of my mother." In other words, this means, "I only drank the nourishing milk of my mother, thanks to which I will defeat you."

In certain ethnic groups, such as the Bamanan and the Malinké, a woman who has given birth must not have sexual relations with her husband until the child has been weaned. This is done in order to space out conceptions. Among the Toucouleur, however, a woman can have sexual relations with her spouse forty days after the birth. On this day, she braids her hair, adorns herself with jewelry, and lights incense in the bedroom to indicate that she is available. If the woman conceives while her baby is still breastfeeding, however, the baby can fall ill because it is drinking milk that has been made hot by the pregnancy. This hot milk will cause the baby to have a fever and uncontrollable diarrhea.

It must be noted that the legitimacy of children is traditionally very important. In certain ethnic groups, an unmarried mother must exile herself far from her village, either at the beginning of the pregnancy if she cannot get rid of the fetus, or near the time of delivery if she has managed to carefully hide her state. She does not rejoin her family until she has gotten rid of the fruit of her and her relatives' shame in one way or another. This is done in order to avoid the insults and the sarcastic remarks of the villagers or townspeople who would boo her without pity. This is the treatment inflicted upon unmarried mothers, and it is injurious not only to the girl but also to her entire family, no matter the social status of its members.

In other groups, an illegitimate child is entrusted to his great-uncle's wife or, failing that, to an aunt or another relative who lives in a different village or town. The child will be raised outside the home of his forebears and his mother, and outside of his mother's village or town.

Other ethnic groups will admit a bastard child into the family, but he will not be treated as well as the legitimate children, who will usually use him as a punching bag.

Among the Malinké, the child born of adultery is held in contempt. Every seven years, when the time comes for the repair of the roof of the *Kabablo*²¹ (the sacred house of Kaba), all of the children who are thought to be born of adultery are discretely advised by their mothers to take a trip somewhere. An illegitimate child will be “found out” if he helps with the repairs, because the moment he touches the walls of the house, no one will be able to lift the side of the newly repaired roof. Through a process of elimination, the illegitimate child would be discovered.

It is very important to note that the sterility of a woman is the worst disaster that can befall a household. This section would be incomplete without several observations about childhood life and children’s education.

Generally, boys are favored at the expense of girls. Boys have an easy life in comparison to their sisters, who are raised in a very strict manner. Girls in the large cities are not subjected as much as country girls to the harsh models of child-rearing and other ancestral customs regarding girls.

Until their circumcision, boys who do not go to school (the majority of boys) are only busy when they work in the fields in preparation for the winter. After the harvest, they are free as a bird. They spend all their time playing or chasing geckos, small rodents, ground squirrels, little birds, etc. Boys are more privileged than girls because a family that has one or more boys does not have to worry about the transmission of the family name to following generations, something which is very important to us.

In contrast, girls are busy during the whole year, picking and spinning cotton, pounding millet, drawing water (sometimes several kilometers from the village), doing the laundry, washing the dishes, helping the women in the kitchen, etc. Girls are only free to play amongst themselves during the moonlit evenings (after all household tasks are accomplished), singing and dancing to the sound of their tired, clapping hands. Girls are raised in this way to ensure that they will be good homemakers and will find a good husband when the moment comes. Their hard work, their docility toward their parents, and their total resignation to the conditions of their lives will win them favor when the time comes for them to be married. Parents who are choosing a

wife for their son will usually prefer a girl from a good family who does not balk at work, rather than a perfect beauty who is reputed to be lazy and disrespectful towards others.

Animist and Muslim girls are allowed to have their heads and breasts uncovered until marriage. They must not wear perfume or incense, however, because this is considered to be cheap coquetry. In our days, girls continue to leave their heads uncovered, but with the appearance of the bra in our country, all the girls in the big cities and an increasing number of girls in the country cover their breasts in public. Once married, Islamic prescriptions rigorously oblige women to keep their heads, and especially their breasts, covered, even at home. This obligation is not imposed on animist women, who can continue to work with their heads and breasts uncovered.

According to our traditions, a child is considered as belonging to all, and his education is the affair of all. This is why when an adult finds himself in the presence of a child who does something which merits being reprimanded, he must immediately correct or lecture the child as his father would have done in the circumstance, even if the child is a stranger. In other words, the adult serves as a substitute for the child's father. Next, he takes the child to his family, and the head of the household will thank him and give the child several slaps or vehement reprimands in his presence, so that the child understands that he has nothing to gain by committing such foolish acts either inside or outside of the home. The child therefore finds himself, at every moment and in every location, under the permanent and vigilant surveillance of the entire village, which considers itself responsible for the education of its children.

Until the 1930's, both Muslims and animists were hostile to French schools. Muslims thought that the schools dispensed "satanic" education, and animists thought they might be able to turn children away from their ancestral beliefs. At the beginning of the French colonization of Mali, schools were provided for the children of chiefs and notables. They were first called "schools of hostages" and then "schools of chiefs' sons." Widespread hostility toward the schools from both religious communities obligated the colonial administration to impose a yearly quota of students that each district was to supply the schools. In place of their own children, many men sent the children of their slaves to the French schools. Many students escaped from the schools, their parents urging them to come home and sometimes even bribing their teachers.

Muslims preferred to send their children to Quranic schools so that they could learn to recite the Holy Quran by heart. Girls who went to Quranic schools only learned enough of the holy book to enable them to pray properly. Boys, on the other hand, had to memorize the entire book and then recite it publicly without hesitating or making any mistakes. This event was celebrated with feasts of mutton and beef.

The animists waited until the end of the initiation period that took place after circumcision to teach the “new men” the secrets of the secret societies (*komo, nama, nia*, etc.) and several rudiments of the occult science of their region which only circumcised men, and not a *bilacoro* (non-circumcised man) or even an excised girl was allowed to know. This knowledge was shared with newly-circumcised men by animist magico-religious priests.

Circumcision and excision

a) General information

In mythological terms, Abou-Djafar Mo’hammed Ben-Djarir Ben-Yazid Tabari (usually known under the shortened form of his name, Tabari), considered to be the first Muslim who composed a general chronicle²², teaches us that circumcision and excision were imposed by God himself. This is what he says: “Abraham acquired great riches and desired to have a child by Sara, but he had none. Sara then said to Abraham: “You will not have children by me. If you want, I will give you Agar, maybe you will have a child by her.” Abraham responded: “I agree.” Sara then gave him Agar, and a little time afterward he had a son by her that he named Ismaël. When Agar gave birth to Ismaël, Abraham was filled with joy, but Sara was afflicted with anger and violent jealousy. Not having control over herself anymore, she had quarrels and arguments with Abraham, and she insulted him. Next, she swore: I will cut off some part of Agar’s body, a hand, a foot, an ear or her nose. But after having reflected, she said: “It is I who committed this fault because I gave Agar to Abraham. It would not be just to cut a part off of this young girl’s body, or to kill her, but I swore to do something, and it is absolutely necessary that I cut something off of her. After having thought about this, she said: I will circumcise her to prevent her from seeking a man. When Sara had circumcised Agar, God imposed circumcision on Abraham’s family and on everyone who followed the religion of Abraham, so that Sara was

obliged to be circumcised, and Abraham as well. It is said that Sara was seventy when she had the operation, and Abraham was ten years older.

The following words concerning circumcision are from the Prophet. In his time, there was a woman named Oumm'Attiya. Once, she passed next to the Prophet, who said: "Oh Oumm'Attiya, where are you going?" She responded: 'Oh, apostle of God, I am going to circumcise.'" The Prophet then spoke several words of which the meaning was: when you circumcise a woman, do not cut off too much skin, so that she keeps the beauty of her face. When too much skin is cut off a woman, the beauty of her face disappears and she is "no longer attractive to men's eyes."

The above examples appear to show that circumcision and excision are sacred.

In non-religious terms, circumcision and excision are customs which have existed since time immemorial. Regarding circumcision, it is thought that the removal of a man's prepuce is both an esoteric and a hygienic act. Excision is justified by the fact that freeing a woman from her clitoris reduces her bodily desires and makes her chaste.

It must be said that men, due to their egoism, have always wanted to keep women for themselves by all means possible, never mind the price paid. For example, soldiers in Middle Ages Europe put chastity belts on their wives before leaving their homes for far-away wars. Other peoples have chosen to take away women's sexual desire by removing the most sensitive part of their genitals. There are also peoples who use excision as a means to "purify" young girls before marriage. Others use excision as an initiatory event which permits young girls to adapt to the life of their people thanks to the teachings they receive from the *sema* or *soma* (the woman in charge of watching over the excised girls during the two weeks of their group retreat).

It is estimated that about thirty African countries practice excision. In spite of legal measures, circumcision and excision will not disappear soon, as customs are resistant to change.

b) Circumcision

Circumcision is practiced throughout most of Mali. In certain ethnic groups, a non-circumcised boy is considered as being an impure being. He cannot be admitted into secret societies and must hide himself (like the women do) during the night when the special representative of one of these societies must leave his den to travel up and down the streets of the

town/village to the sound of tam-tams and the cries of his servants. He also does not have the right to touch sacred objects.

In the majority of ethnic groups, circumcision is performed by a blacksmith²³, who is also in charge of healing the “post-op” boys.

Immediately after circumcision, the newly-circumcised youth begin an initiation period. They spend one, two or three months (according to their ethnic group) in the bush, looked after by a *sema* (teacher-healer). The youth will learn the history of their people, their customs, how to handle weapons, how to use certain medicinal plants, the secrets of their regional society, etc. In brief, the youth will learn what will make them complete men, in the largest sense of the term.

It is easy to see the importance that Malian people attach to circumcision. For example, boys who are circumcised together (the operations are performed collectively) form an age class of which the members owe each other assistance and solidarity during their entire lives. Until the recent past, both Muslims and animists celebrated circumcisions with large, week-long festivities, during which animals were sacrificed, and people sang, danced, and gave themselves over to excesses. This still happens in the countryside, but hardly at all in the urban areas, where the doctor’s scissors are replacing the blacksmith’s knife.

The end of the initiatory period of the boys, who have now become men, is followed by another ritual ceremony. This ceremony is less spectacular, but still joyous, and sometimes gives rise to tam-tam playing. The new men have the right to wear pants, which replace the *m’poqui* (similar to underwear) that they wore before.

c) Excision

Excision is less widespread than circumcision, because certain ethnic groups either consider it to be optional or do not practice it at all. The procedure is usually performed by a woman from the blacksmith caste. The woman is also in charge of healing her “post-op” patients and supervising the woman who is in charge of looking after them.

Contrary to circumcision, excision takes place discretely in the Muslim population, where the operation occurs several days or weeks after a baby girl’s birth. In the animist community, excision is accompanied by festivities filled with excesses.

Animist girls are usually excised between the ages of twelve and fourteen, though some are even older when they undergo the operation. During the period which follows excision, the newly-excised girls are shut up in the same hut, where they learn all that an informed woman must know about sexual techniques, household work, basic information on her people's history and traditions, how a wife should behave toward her husband, etc. In brief, they learn everything which will make them good wives, good mothers, and participants in the habits and customs of their people.

Infibulation, which consists of sewing the vulva of a young girl and leaving a small orifice for urination and menstruation, the goal being the preservation of her virginity, is not practiced in Mali.

Death and funerals

According to Islamic instruction, the body of a person must be immediately buried after his death. Normally, funerary ablutions must be made immediately by a marabout (if the deceased was a man) or by an older woman who knows the ritual and the prayers that must be muttered (if the deceased was a woman). The body is then wrapped in a white shroud. At the same time, youth are sent to the cemetery to dig the grave for free. There are no paid gravediggers in Malian Islamic culture, and the Muslim religion does not permit graves to be dug in advance of bodies to come. The funeral prayer is performed by the Imam of the mosque where the defunct prayed. In his absence, a marabout or someone else who is believed to know the appropriate prayers performs this service. The family, friends and acquaintances of the deceased are placed in close rows behind the Imam or marabout.

There is a tradition in certain ethnic groups that marabouts fight in vain. This consists of the preadolescent children of the deceased demanding money after his burial from his other children and their friends. They make an uproar by banging pieces of calabash together and making fun of the deceased for turning his back on good couscous and millet cakes. Among other groups, this practice is carried out on the day of the funerary prayers, which take place after the burial. Muslims are against this practice because it comes from the paganism which existed before Islam in our country. This practice is so anchored in the traditions of some ethnic groups that no one has been able to eliminate it totally.

If a deceased man was married, his widow or widows go into mourning by dressing simply. They do not wear finery and must not wear makeup or perfume. This is done in order to ward off men, because widows must respect the chastity period imposed by Islam. The length of a widow's period of abstinence is four months and ten days if she is a noble or a woman of caste and two months and five days if she is a slave or a descendent of slaves.

The mourning period ends immediately after a pregnant widow gives birth. She is freed from completing the rest of the mourning period, even if she gives birth only several days after her husband's death. Contrary to what some people say, the statute applied in this case is that of the nobles, as the Quran makes no distinction between nobles and people of caste (the caste system is a human, not a divine, invention, so there is no difference between nobles and people of caste when it comes to applying Quranic instructions). If the child born to the widow is a boy, he is automatically given the name of his deceased father. This differentiates children born before the death of their father from the child who came into the world after his death.

If it is the wife who dies, the husband has no obligation to fulfill except to observe an appropriate attitude of reserve for an indeterminate time period. He can therefore remarry quickly.

Certain widows and widowers will have marabouts make prayers for the deceased the day after or the third day after the death. Others have them pray on the third, seventh and fortieth days after or on the anniversary of the death, but this occurs very rarely. The marabouts read the Quran or the *dalalil khairat* or perform the *fidaou* (shortened prayer) for the happiness of all the participants at the ceremony and all Muslims still living, and also for the eternal happiness of the deceased and all Muslims gone to the beyond. The marabouts are compensated according to the means of the deceased's relatives or according to the importance of the liturgical prayers that they performed for the deceased's soul's rest and for him to be among the chosen ones who go to Allah's paradise. After the ceremony, cola nuts are distributed and the guests depart while wishing each other that a very long time will pass before they meet again in such circumstances. There are no displays of joy. On the contrary, all noisy displays are banned in the deceased's family for as long as possible.

Funerary customs are different in the animist community, notably among the professional hunters who belong to different organizations that are assembled together in a dynamic National

Federation²⁴. When a master hunter or a hunter reputed for his exploits dies, they organize a wake, where they spend the whole night dancing, firing guns into the air, drinking alcohol, and listening to the *donso-diéli* (hunter's griots) who praise the deceased by exalting his vast knowledge of the hunters' guardian divinities' instructions, his skill at hunting, and his rashness in the face of wild animals (of which he killed many). An incantatory ritual believed to allow the defunct to easily enter into the heart of the circle of happy ancestors is carried out by a master hunter reputed to have occult powers.

In other regions of Mali, the burial of a non-Muslim is accompanied by complicated ritual performances, followed by magnificent libations before and after the interment. Sometimes the body is displayed for several days and nights, during which relatives and friends come to give messages to the deceased so that he may deliver them to their relatives in the beyond. Generally, the heads of animist widows are completely shaved and their bodies covered with a solution composed mainly of ashes.

Inheritance

Inheritance rules are different in the animist and Muslim communities.

Among the animists, a widow is not only totally excluded from the inheritance, she is a part of it. A woman is considered to be a part of her deceased husband's estate, especially when she was the object of an exchange between two families. A widow is systematically allocated to one of her husband's brothers, generally the youngest. Sometimes the widow is allowed to choose which brother to marry, but this is not always the case. In general, the family council decides which brother will take her. She does not have the right to balk at the choice which has been imposed on her. Sometimes the adult sons of the deceased are allowed to take his young widows. This system tends to keep goods within the family, managed by the patriarch. In certain ethnic groups, when a widow wants to leave her deceased husband's family, she must leave everything she, her husband, or the couple acquired during the marriage. She leaves the household empty-handed. Sometimes her husband's family demands repayment of the dowry that was given to her at the time of her marriage. This shows to what extent married women are considered to be a part of the family patrimony.

A Muslim woman has the choice to remain a widow within her deceased husband's family or to marry one of his brothers. She is free to choose which of the brothers she will marry, which often results in tension, arguments, and other turmoil between suitors. The widow is also free to leave the family and marry another man.

Contrary to animist women, Muslim women are not part of their husbands' estates. Rather, widows receive part of their husband's estates as determined by Islamic law. A Muslim widow who has children receives one-eighth of her husband's estate, while a childless widow will receive one-quarter.

Daughters of the deceased receive only half the portion of the estate that their brothers receive. This inequality is justified by the fact that when the daughters marry, they will bring their portion of the estate into their husbands' families. This would take away a part of their father's family patrimony, which was put together through the efforts of the male members of the family. Thanks to this system, male privilege in terms of inheritance is preserved, and an important part of the family goods are safeguarded in the case where the boys stay single.

Among the Muslims, each heir and heiress has the right to dispose of his/her part of the inheritance as s/he pleases.

Scarification and tattoos

a) Scarification

This section is about incisions made on the face for aesthetic reasons, in accordance with custom. Depending on the ethnic group, certain incisions of this type are deep, while others are superficial. In certain groups, deep scarification consists of three long slashes on the temples, starting from the ears and ending at the chin. In other groups, deep scarification appears as a single scar on one or both cheeks, which goes from nose to cheek or cheek to mouth. Superficial scarification consists of two or three small incisions on the forehead, the temples, the cheeks and the chin. Others are under the eyes. Scarification is usually performed by women blacksmiths. Incisions are generally received during early childhood.

Scars serve to identify individuals. Each ethnic group or combination of ethnic groups has specific scars thanks to which their members can be identified. For example, long scars on the temples are generally associated with the Malinké, the Bamanan Massassi, the Khassonké²⁵,

the Diawara, etc. The Toucouleur scarification consists of two small scars on each temple. Scars on the forehead, temples, cheeks and chin are usually made by the Soninké. Scars found under the eyes are associated with the Peulh women of Macina. In certain regions, women's entire bodies are embellished with raised scars. The designs of these scars can sometimes be very beautiful.

Scars that are used for identification of individuals are obligatory in certain ethnic groups. In other groups, scarification is merely decorative. Whether customary, sacred, or decorative, scarification is disappearing because it is not usually practiced in urban areas.

b) Tattoos

This section is not about printing colored and permanent designs on the body as is done in Western countries. Rather, this section refers to "bluing" the lower lip of young girls.

When several adolescents of the same age class decide to have the procedure done, they discretely contact a tattoo woman, sometimes one who lives in a nearby village or quarter, in order to avoid bringing their families' attention to the matter, and they set the tattooing date. During the early morning of the appointed day, the girls get together and go to meet the tattoo woman. As with circumcision and excision, the woman, a *nyamakala* (of the cobbler sub-caste) herself, traditionally tattoos a *nyamakala* girl first. *Nyamakala* are thought to be less vulnerable to the ravages of evil spirits, so starting with a *nyamakala* girl will allow the other girls to avoid the evil actions of these spirits when they are being tattooed. After this, someone will be sent to alert the parents of the other girls, who will go to join them, accompanied by tam-tam players. A tam-tam party with women from the surrounding area is immediately organized. The operation is accompanied by tam-tam drumming and songs of encouragement because it is extremely painful.

The young girl to be tattooed lies on her back and places her head on the woman's thighs. Another woman will be near the girl, and will tap her on the chest and encourage her to endure her suffering so that she does not bring shame to her relatives by crying out or writhing in pain. The girl must also keep her eyes open to prove that she is not afraid. The operation is so painful that some girls do cry out and writhe in pain, and some run away before the tattoo is finished. These girls will be marked for their entire lives, and will bring shame on their relatives.

The tattooist hits the girl's lip very hard to the rhythm of the tam-tams and songs with fat, long, pointed thorns wrapped together with string. The girl's lip will bleed heavily, and the tattooist will stop the blood flow by applying coal powder on the wound. When the girl's mouth is filled with blood and coal, the woman invites her to spit and begins to hit her pained lip with the thorns again. The spitting takes place several times before the end of operation, which usually lasts about an hour.

At the end of the operation, the woman wraps the girl's swollen lip in a piece of black fabric and fastens the ends above her head. The girl drinks milk through an empty reed until the third day, when the fabric is removed, her mouth is slightly opened, and some tô (millet cake) is placed in the back of her throat. Approximately a week after the operation, the bandage and the crust that has formed around her lip are removed. At the end of this entire process, the girl's lip will have a permanent blue color. In certain ethnic groups, notably the Peulh, both lips are tattooed in this way. This type of tattooing is rarely practiced anymore, especially in the big cities. Some women have their gums tattooed periodically for aesthetic and sanitary reasons. Coal powder is also used for this process, and the powder and blood mixture turns the gums blue. Tattooing the gums is believed to strengthen the teeth. Gum tattooing is performed by a woman from the cobbler caste. The tattooist goes house to house with her tool kit (small packs of spines, coal powder stored in horn, etc.) and offers her services to women. The operation is not accompanied by any rejoicing or festivities. Rather, it takes place in silence. The gum tattooing process is much less painful than the lip tattooing process, and the procedure does not last more than fifteen minutes. The pain is fleeting, and does not prevent the woman carrying out her daily tasks. Gum coloring must be renewed several months after the procedure, because eating and drinking makes the blue color fade. Gum tattooing is still practiced in both the country and the urban areas, although the procedure is becoming less common.

Lip tattooing does not have an esoteric character and is not required by custom. Nevertheless, it is an integral part of Malian customs, like the other traditional behaviors described in the preceding pages. In other times, a young girl who did not have her lower lip tattooed was considered to be a coward, and was subjected to public jeers and taunts. Therefore, it was a custom that all girls respected. This is not the case today.

Taboos

In Mali, there exist many social and moral taboos. Some of these have a religious origin, while others come from our ancestors, who noticed that certain behaviors always had harmful consequences. The majority of these taboos are not formal, but the fear that they inspire, helped along by popular stories and exaggerations, have given them a sacred character. Those who know a taboo will consciously try not to break it.

It is said that when someone would ask El hadj Oumar Tall, the Toucouleur conqueror from Fouta-Toro who brought Islam to Mali, what he thought about non-Islamic taboos practiced in the areas he had conquered, he would reply as follows: “If someone draws a line on the ground and says that whoever steps over it will die, tell him that this is not true, but walk around the line when passing by it. In other words, deny the power that the drawer attributes to the line, but take care not to step over it to prove it has no power. Don’t experiment with it yourself.”

Taboos do not exist only in Mali. Social and moral restrictions are present everywhere in the world. In Western countries, for example, isn’t it said that thirteen people cannot sit at the same table? Isn’t it also said that passing under a ladder or lighting three cigarettes in a row with the same lighter is unlucky?

There are numerous and varied taboos that exist in Mali today. Several ethnic groups often follow the same taboos, but they can also follow taboos that are unique to their own group. The following is a list of several traditional, but relatively unknown, taboos.

- Do not throw fruit pits in the bush, because they could fall in the eyes of evil *djinns*. These *djinns* would then avenge themselves.
- Do not eat anything in the field without first pleasing the spirits who live there by throwing a pinch of your food to the right and left.
- Do not leave your prayer rug spread out after finishing your prayers or Satan could urinate on it and render it unclean. It would then be impossible for your prayers to reach God. Always fold the rug after each prayer.
- Put on your pants only while sitting down, not while standing up.
- Drink only while sitting down, not while standing up.

- Do not walk over any traces of urine, because you could be contaminated if the person who urinated has gonorrhea.
- Do not eat or drink with your left hand.
- Immediately bury all hair, beard and nail clippings. If you leave them lying out, your enemy could take them and use them to harm you.
- Do not suddenly awaken anyone who has been sleeping soundly. His double, who has been out wandering, will not have time to reintegrate into his body. He could then lose his spirit and become dumb or insane.
- Do not marry a woman who has already lost two husbands, or you could become the third. As the saying goes, there is “never two without three.”
- Do not give a stranger anything to eat or drink without having consumed some of it beforehand.
- Do not offer medicine to anyone without having consumed some of it in his presence to show that you are trustworthy.
- In the case of a death, the relatives of the deceased must not accompany anyone to the door who has come to give their condolences, because this will bring misfortune.
- In the case of a death, the relatives of the deceased must not return furnishings and mats that they borrowed for the funeral, because this will bring misfortune. It is up to the lenders of the objects to come and retrieve them.
- Muslims are only allowed to eat the flesh of animals that have died by having their throats cut. This is why hunters must hurry to cut the throat of an animal they have brought down before it dies.

Many taboos are not respected by young people because they are not familiar with them. When something undesirable happens to a youth, he might go to a *marabout* or a *féticheur* to find the reason for his troubles. In the majority of cases, the *marabout* or *féticheur* will attribute his troubles to the breach of a certain traditional taboo.

Elders and their role in the education of young children

Two examples show us that the effect of age on a human being has inestimable value:

- a) In the traditional Bamanan community, one can frequently hear the following song: “*A yé ta dougoutigui fô sô koro*” “*Demissin mâcoro n'tan ka kiri mandi*,” This can be translated as: “Go greet the chief of the village or other adults,” which means: “A young child without an aged person nearby is not very capable of negotiation and conciliation.” Advanced age brings with it the ability to be a moderator and peacemaker/keeper.
- b) The illustrious thinker and man of letters Amadou Hampaté Bâ states that every old person who dies is a library that burns. This highlights the immense treasure of knowledge that disappears with the death of an old person, especially in illiterate areas.

As shown by the above examples, it is natural that old people should be considered when speaking of the education of young people.

To respond to the expectations of what this book should accomplish (see foreword), the most senior members of AMASPA found it necessary to bring up the following preliminary questions:

- When and where do old people participate in the education of children? In other words, what kinds of educational programs exist or can be created that will include old people?
- What kinds of activities can old people lead?
- What kinds of people can be called on to help with the program?

In order to address these questions, it is important to take into account the informal and formal educational settings that exist in Mali.

The informal setting comes from authentic African tradition. Every old person is responsible for the education of children, no matter when and where. Every old person is the teacher of every child. An old person would betray his tradition if he let a child get away with inappropriate behavior because he is not directly related to the child. Likewise, each child must consider every nearby adult as a relative and a teacher. This conforms to our shared mentality, which can be expressed by the following proverb: “*Ni-î-tarra yoro-o-yoro, ni-î-ma fâ ni bâ soro, i-ma gnini dé.*” This means: “Everywhere you go, if you find neither a father nor a mother, it is because you have not looked, and you have not merited them.”

The entire traditional African society is thus an informal setting for the education of young people. This education takes place in widely varied domains: the obligation for young people to greet adults, politely give up their seats or paths, use polite language in the presence of

an old person, especially a stranger, apply integrity and honesty in all affairs, be prepared to help old people who need it, and be willing to take in the infirm, orphans, and all those who need help.

A vast campaign of renewed conscious-raising in relation to this precious ethic should be undertaken in both the villages and urban areas. This campaign is very important, because social evolution as it exists today tends to destroy human values both in Africa and elsewhere.

AMASPA should limit its use of television, radio and newspaper publicity for this campaign. Several formal structures and modes of intervention already exist or could be created. For example:

- Associations of students' parents, which often contain a number of old people. These elders can institute varied interventions for adults and children.
- Educational establishments such as kindergartens, public and private schools, and other institutions (handicapped establishments, the Village SOS²⁶ in Sanankoroba, etc.). Old people close to these establishments should constantly feel responsible for the successes and failures of the establishments, both as old people and as relatives of future students.
- Various councils (neighborhood, village, professional) of which all people are members. It is up to them to highlight, during meetings, the damaging effects of moral decay and the many benefits that can come from good educational settings. The councils, consulted at all levels by the authorities, must contribute to decision-making that concerns healthy social development. These councils must also directly educate young people when they are able.

The following categories of people should be included in the program (this will vary by region):

- Farmers, animal breeders, fisherman and old hunters
- Retired administrative professionals
- Persons of caste and artists

Conclusion

It is important to highlight that our ancestors perfectly understood that human beings must not act as if each one of them constituted an end in himself. On the contrary, each

individual is part of a society, and all must work to ensure that the society survives. This is why our ancestors instituted behaviors and customs that allow each one of us to know what we must or must not do regarding the community and other people. These behaviors and customs have been transmitted through generations.

These behaviors and customs are in the process of losing their value, certainly in the urban centers where individuals come from all different areas and belong to different ethnic groups. In the countryside, these behaviors and customs retain (more or less) their original form.

Polite behavior is also losing its value. Few young people today have the respect due to old people. Rare are those who salute old people in the street or give them their seats. On the contrary, they give them a look which says: "I don't know you, so I don't owe you anything." For example, when an old man is in the presence of young people drinking tea, they don't even raise their heads to look at him, let alone greet him. They defend themselves by saying: "He found us here, so he should greet us first." If the old man does greet them, they do not respond.

Times have indeed changed. In our days, an old person usually has to have some sort of power in order to be respected by adolescents. Today, girls and boys can be seen taking walks together in the streets, something which in other times constituted a monstrous scandal and was punished with a public beating.

The wise Amadou Hampaté Bâ (peace to his soul) taught us that every time an old person dies in Africa, a library burns. Sadly, there are few adolescents who go to these "libraries" to learn the culture of their people. Youth are most often preoccupied by their daily problems and not by the knowledge of the sociocultural structures instituted by their ancestors or the cardinal virtues of their people (strength, wisdom, solidarity, civil engagement, justice and organizational abilities). In brief, the good manners inherited from the ancestors are being lost in the big cities. Even the rules of hospitality are starting to be lost in the cities. Only friends and relatives that one wouldn't dare turn away are received. The legendary hospitality of the Malian people is only found in its quasi-original form in the countryside where the people are still faithful to it.

As for marriage, choosing a spouse is no longer the prerogative of parents in urban areas. Boys and girls meet each other in the streets, at the markets, in bars and clubs, etc., go out for a while, and tell their parents that they want to get married. They do not check out each

other's relatives to ensure that their future spouse's family is honorable and has a good reputation. Rather, children put their parents before the *fait accompli*. Parents are losing their authority in this area. Resigned parents shake their heads sadly and say: "In the past, parents were the hens who walked before their chicks, and today they are the ducks who follow their ducklings." Children used to follow their parents by accepting what they told them or decided for them. Parents today must bow before the decisions of their children. We are experiencing a veritable resignation of parents, which has led to the deplorable decline of good morals. This is one of the causes of the juvenile delinquency which is reaching astonishing proportions in our cities.

This "relaxing" of good morals also effects sexuality. Today, staying a virgin until marriage is the least of a girl's worries. There are some rural girls who stay virgins until the first night of marriage. The girls who aren't virgins will respond to their husbands' reproaches by saying: "If it is blood you're looking for, go look for it in the slaughterhouse." To safeguard the honor of a conservative family, the *magnomakan* (the woman *nyamakala* in charge of watching over the new wife during the first week of marriage) may, with the complicity the daughter's mother and husband, drop several drops of chicken blood on the loincloth so that it may bear witness to the girl's "virginity" and be exhibited to the public as customs describe.

There is also no more shame resulting from the birth of a bastard child. The birth of a child outside marriage is sometimes even celebrated, and the child is baptized, just as a legitimate child would be. However, infanticide has become common, and children are left to themselves: they are rarely watched over and looked after. They are raised by the streets, in the streets.

In conclusion, parental, social and cultural values handed down by our ancestors are increasingly being rejected and ridiculed. The good behavior and good relationships which made our precursors proud are, unfortunately, in the process of disappearing and are being replaced by outside cultural influences.

It is not uncommon for rural youth to want to escape the constraining value system governed by customs and feel that they are being deprived of something important in life that can only be found in cities. They come to the urban areas and swell the ranks of city-dwelling delinquents. Other young people think their own personalities have been stifled and are afraid of

not being happy. These young people enthusiastically deliver themselves to the escape provided by drugs and alcohol.

We must not, however, beat all young people with the same stick. They are not all *dangaden* (bad children). There are some *douaouden* (good children) who respect and help their elders, thus perpetuating our old traditions. May they be congratulated and blessed!

I must be honest, however, and recognize that some old people also break behavior rules. But this should not prevent young people from respecting them, because it is their white hair that counts and not their manners, however blameworthy they are. A proverb of ours says: “Even if an old person is not a friend of God, it can in any case be said that they stayed together a long time.” This means that after being alive for a long time, Allah has breathed some of his knowledge and his power into old people, and young people would be wise to use this to their advantage.

Young people feel that they are abandoned by their elders because they do not or cannot help them with the multiple problems that confront them daily. On the other hand, the old reproach the young for not listening to the advice that they generously give because they consider it outdated. They have concluded that it is useless to waste their time on the young. Here is a regrettable incomprehension that is harmful to our society, and it would be wise to remedy this situation.

No matter what, it is important for young people to regain their self-control and try to learn the ancestral knowledge of their people from their elders, so that they may adapt it to their lives rather than throwing it away as a growing number of them do now.

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1. In many Western cultures, the word “old” is often used in a pejorative manner, referring to something that has lost its value or no longer has any relevance. Becoming “old” is something to be feared, as it implies that a person can no longer relate to the world around them. In Malian culture, however, old age is equated with wisdom and fulfillment, and old people are respected as the guardians of knowledge and educators of the young (Bâ 1972). Readers should keep this in mind as they encounter terms such as “old” and “elder.”
2. The Peulh (also known as the Fulani or Fulbe) are a primarily Muslim, traditionally pastoral people scattered throughout West Africa. The Peulh represent 17% of Mali’s population (“Fulani,” “Mali”).
3. Many languages possess both formal and informal forms of “you.” The formal “you” is used to show respect, while the informal “you” is used when speaking with someone who is of similar age or status. In the English language, the possessive pronoun “your” is paired with a term of respect such as highness, majesty, grace, etc. to create the equivalent of a formal “you.”
4. The *arbre à palabres* (tree of words) is a building or large tree in the public square of a village. The *arbre à palabres* serves as a place of communication and conflict resolution: villagers, elders, and the village chief gather here to address questions and resolve disputes (Konaté).
5. Meals are typically communal, with each diner eating from the same container with his right hand.
6. A *djinn* is a spirit which may be helpful or harmful (Bravmann).
7. The cola (or kola) nut is a two-inch long, caffeine-containing brown nut (“Kola nut”).
8. The Toucouleur (or Tukolor/Tukolor) are a Muslim people who inhabit Senegal, Mauritania and western Mali. The Toucouleur typically fish, raise stock, and cultivate crops. The Toucouleur represent less than 5% of the population of Mali (“Tukolor,” “Mali”).
9. A Macinanké is an inhabitant of Macina, a historic village located in the Segou region of Mali (Coulibaly).

10. El Hadj Cheik Oumar Tall (or al-Hajj 'Umar ibn Sa'id Tal) was a Muslim cleric from Fouta Toro (now in Senegal), who conquered portions of modern-day Mali, Guinea and Senegal, forming the Muslim Tukolor empire (1848-1897) (“Umar Tal”).
11. The *nyamakala* are composed of the following castes: smiths, weavers, woodworkers, leather-workers and *griots* (also called *dieli*). *Griots* are divided into three groups: musicians who preserve ancient music and compose new melodies, ambassadors who specialize in conflict resolution between great families, and genealogists, historians, or poets who preserve oral culture (Bâ 1981).
12. The Bamanan (Bambara) are an agricultural ethnic group who belong to the Mande group of West African peoples. They are the largest (and most dominant) ethnic group in Mali (“Mali: Overview”).
13. The Soninké (also known as the Sarakolé) belong to the Mande group of West African peoples. The Mande represent 50% of the population of Mali (“Mande,” “Mali”).
14. The Diawara are a minority ethnic group in Mali who speak the Soninké language. They represent approximately 1% of the population of Mali (1991) (“Mali: Overview”).
15. “The term (marabout) is used regularly by francophone West Africans and Western scholars alike, and can refer to imams, teachers, scholars, preachers and saints, to the leaders of religious ceremony or of Muslim brotherhoods, as well as to any type of specialist in esoteric knowledge including producers of amulets and diviners (Gemmeke).”
16. The word *Massa* means “king” in the Bamanan language, and *Massassi* means “to be from the lineage of the king (Coulibaly).”
17. The Bobo are Voltaic farmers and fishers who live primarily in Burkina Faso but also inhabit the San and Tominian regions of Mali. The Voltaic group of peoples represents 12% of the population of Mali (“Bobo,” “Burkina Faso: Overview,” “Mali,” “Mali Overview”).
18. Mali, along with several other former French colonies in West Africa, shares a common currency called le franc de la Communauté Financière Africaine (FCFA). In 1999, the FCFA was pegged to the euro at $FCFA\ 655.957 = \text{€}1$ (Omozuanvbo and Mbaku, Gulde and Tsangaride).

19. The Hajj is an annual pilgrimage to Al-Ka'bah ("House of Allah") in Mecca, Saudi Arabia, which takes place during the twelfth month of the Islamic calendar. All Muslims who can afford to make the pilgrimage are obliged to undertake it at least once (WHY-ISLAM Project).
20. From dawn to sunset during the month of Ramadan (the ninth month of the Islamic calendar), Muslims must refrain from eating, drinking, smoking, and having sex (WHY-ISLAM Project).
21. *Kaba* is the former name of the village of Kangaba. A *blo* is an entryway or hall where the elders of a village meet to discuss important matters relating to the village or region. The *Kabablo* is thus a meeting place for elders in Kangaba. This historic structure is reroofed every seven years, and people from around the world attend the ceremonies and celebrations which accompany the event (Coulibaly).
22. "Les Prophètes et les Rois" de la création à David (volume) De. Sindbbad, 1 et 3 rue Feutrier Paris (18è) page 144.
23. Blacksmiths are a sub-caste of the nyamakala. Male blacksmiths are responsible for circumcising and shaving men. Women blacksmiths (and griots) are responsible for dressing women's hair, performing excision, assisting in childbirth, etc. Along with other sub-castes, blacksmiths are assumed to have a mythological ancestor (stories vary among ethnic groups), and some believe that blacksmiths still maintain a connection to the spiritual world (Béridogo).
24. "During the pre-colonial era, the hunters' associations used to be responsible for meat supply and village protection. Today they are active at all political and social levels (Caspary)."
25. The Khassonké (also called Xaasongaxango) are a minority ethnic group in Mali who speak a language similar to Bambara. They represent approximately 1% of the population of Mali (1991) ("Mali: Overview").
26. SOS Children's Villages International is a non-profit organization which works to prevent family separation and helps to strengthen SOS families and foster families, "which provide stable and consistent care to children who cannot remain in their family of origin, and for whom family-based care is considered the best option." In addition,

SOS helps communities with their education and infrastructure needs, and speaks out for children who have lost a parent or whose parents cannot take care of them. SOS Children's Village Sanankoroba consists of thirteen family houses, representing 130 children, along with administrative buildings and a small ward. SOS also operates a kindergarten and primary and secondary schools, which serve children from the Village and surrounding areas (SOS Children's Villages International).

Discussion Questions

- Which customs and traditions described in the book are the most different from and the most similar to your own?
- If a Malian man from a rural village visited your country, what do you think would surprise him the most? What about a Malian woman?
- As you have learned, friendly conversation is a very important part of daily life in Mali. What would you do if you were in Mali and wanted to converse with a stranger, but neither one of you spoke the same language?
- Why do you think that senenkouya is such an important part of Malian life? Do you have anything similar in your culture?
- What should you do when you first arrive in a Malian village?
- What are some differences, according to the author, between city life and village life in Mali?
- Do you belong to any clubs or associations? How does your association differ from the men's or women's associations described in the text? How is it similar to these associations?
- Some of the taboos listed in this section may seem strange or different to you. Can you think of any taboos in your culture that would seem just as strange to a person from Mali?
- This book has provided a general overview of Malian culture. Is there a particular tradition or custom which you would like to know more about?

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Title: National and Local Perspectives on Radon Resistant New Construction Policies

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Abstract

Purposes/Aims: The three aims of this study were to: 1) conduct a national inventory of radon resistant new construction (RRNC) policies in state or county-level laws, 2) test for an association between geographic risk and existing policies, and 3) administer a survey to building industry members to learn their perspectives on local RRNC.

Rationale: RRNC policies have been adopted in some states in response to increasing awareness of the role of radon in lung cancer. Evaluation of current RRNC policy as well as perceptions of local building industry members is necessary for practical and thoughtful implementation of the Healthy People 2020 objectives. Montana, a state with high radon risk and no state-level policy, may benefit from industry-level opinion as new policy is crafted and adopted.

Method: A national policy inventory was conducted for radon related administrative or constitutional statutes, codes, and regulations then used to test for an association with high-radon risk. Descriptive interviews were conducted with industry members involved in state-level building code policy at the field level. From these interviews a questionnaire was constructed to investigate fundamental concerns and applications of RRNC policy. Members of the Southwest Montana Building Industry Association (SWMBIA) were then surveyed for their attitudes and perceptions to the RRNC objectives of the Healthy People 2020 Plan.

Results: States range widely in number and purpose of radon policies. An analysis of the differences in these policies compared with geographic radon risk level and the resulting RRNC industry costs revealed critical distinctions for future policy framework. The odds were five times greater that states with more radon risk had implemented at least some level of RRNC compared to states with less radon risk ($\chi^2 = 2.34$, OR = 5.00, 95% CI 1.2 - 19.3, $p < .05$). While

this is a descriptive analysis and includes states where only one or two counties have implemented RRNC in an overall high-risk state, the results indicate that the policy initiatives are directionally positive and associated with geographic risk. Survey of local industry members (n=22) reported that their projects included installation of radon systems at least occasionally with 72.7% (n=16) stating that most or all projects included a radon system. Despite the common practice of installing radon systems, respondents were divided on their agreement that an RRNC policy should be incorporated into Montana Building Code (for = 9 (40.9%, against = 13 (59.1%)).

Implications: The policy inventory results indicated that high-risk states are increasingly adopting RRNC to reduce rates of radon-related lung cancers. A survey of local industry could direct policy responses to HP 2020 and public pressures in high-radon, politically conservative states. Industry thoughts conveyed through survey results provide a background for more effective policies to be crafted. Using a collaborative approach, public health nurses may contribute to RRNC policy for Montana that incorporates the concerns of building industry members in this high-radon state. This information may contribute to a thoughtful public health solution utilizing a collaborative approach with the building industry as partners.

National and Local Perspectives on Radon Resistant New Construction Policies

Introduction

Radon, a known carcinogen, is the second leading cause of lung cancer in the U.S. after smoking (Environmental Protection Agency, 2008). Epidemiological studies have provided convincing evidence of an association between indoor radon exposure and lung cancer, even at the relatively low radon levels commonly found in residential buildings (Lubin & Boice, 1997). Radon, a natural air pollutant comes from radioactive decay of Uranium-238 present throughout the earth's crust. Indoor levels of radon are higher than the naturally occurring outdoor levels, significantly in homes and other small buildings. Radiobiological research suggests bronchial epithelium exposed to radon progeny is damaged at the cellular level proportionate to number of cells exposed. For most of the population, exposure to this radiation is determined mainly by the concentration of radon in the home (Gray, Read, McGale & Darby, 2008).

Approximately 2.1 million of the 76.1 million existing single-family homes in the United States in 2005 had radon reducing features in place (Environmental Protection Agency, 2008). Socioeconomically stressed populations are at a higher risk for radon related lung cancer. This population is not only exposed to higher rates of cigarette smoking, but additionally reside in homes built without radon resistant construction or mitigation systems. Addressing this health disparity poses several different approaches.

Background

In 2005, the World Health Organization established the International Radon Project to identify effective strategies for reducing the health impact of radon and to raise public and political awareness about the consequences of long term exposure to radon. International Radon Project members published their recommendations for reducing the radon health risk including

an evaluation of six radon control options for the construction industry and building professionals (World Health Organization, 2009). The radon prevention strategies for new construction focused on “sealing radon entry routes and on reversing the air pressure differences between the indoor occupied space and the outdoor soil through different soil depressurization techniques” (World Health Organization, 2009). Often it is a combination of strategies that provides the most effective reduction of radon concentrations where active radon levels are compared with mitigation needs and policy.

At the national level, the Environmental Protection Agency (EPA) (2011), the Department of Health and Human Services (2010a), and the President’s Cancer Panel (2009) have all established a public health agenda in response to the radon threat that include adoption of radon resistant construction practices. Noteworthy, however, is that the recommended approaches to RRNC policies vary from wholesale adoption of the International Building Code to limited implementation in high radon areas. The members of the President’s Cancer Panel recommended sweeping “building code changes” to reduce indoor radon concentrations. This recommendation called for venting in all new construction whereas the architects of the Healthy People 2020 advocated for a more selective approach. Their recommendation proposes 100% of the homes in high-radon geographic areas to be built using RRNC in Objective EH-15 (U.S. Department of Health and Human Services, 2011). Suggested methods for RRNC practice defer to maintaining consistency with national programs, regulations, policies, and laws, such as the International Residential Building Code (Appendix F) which provides building instruction and layout of systems.

Montana has 56 counties, 49 of which are designated by the EPA as Zone 1. This is the highest-geographic risk designation and means that the average indoor radon level is above the

EPA's designated action level of 4.0 pCi/L (Environmental Protection Agency, 2013). Montana is well placed to introduce radon policy due to its radon risk, lack of state wide policy and rural demographic suggesting increased health disparity among housing and access to services. All new buildings constructed in Montana both residential and commercial must comply with the Montana energy code as of 2010 (Montana Department of Environmental Quality, 2012). This precedent of introducing statewide building code policy ensures the people of Montana have comfortable, energy efficient, cost effective homes and commercial buildings. The state of Montana is primed to receive equal treatment in their comfort and knowledge of safe indoor air quality in their homes and public buildings. Additionally, there are currently no disclosure laws for rental properties regarding indoor radon levels. As a result rental properties are less likely to have been tested for radon or to have been remediated if levels are known to be high. Low-income homeowners may find remediation cost prohibitive as well. By addressing new construction policies, radon can be controlled at the onset of building thereby reducing some of this health disparity burden.

Locally, only one county in Montana has preempted Montana state law and adopted a building code addressing RRNC. Building industry members in Billings, the seat of Yellowstone County, recently adopted RRNC into their local practices. As awareness of radon health effects continues to grow within the housing communities, Montana may continue its course in affecting RRNC policy setting trends for other like-minded Western states with similar radon risk.

Because of the high risk for radon in the state of Montana and uncertainty about the national regulatory framework, a study with the following three aims was crafted. These three

aims were to: 1) conduct a national inventory of radon resistant new construction (RRNC) policies in state or county-level laws, 2) test for an association between geographic risk and existing policies, and 3) administer a survey to building industry members to learn their perspectives on RRNC.

Method

A literature review of municipal, state, and national radon-related policies was conducted in each of the 50 states. A query of statutory, administrative or constitutional statutes was performed using LexisNexis Academic; a searchable electronic database of legal documents, for any statute that had contained the term “radon” at least five times. Results were cross-referenced with the EPA’s database of states and jurisdictions with RRNC code. See results of the query in Appendix 1. Additionally, results were compared to articles in the Radon Reporter (Barber, 2010), the popular media (McCanna, 2012), and the Environmental Law Institute (Environmental Law Institute, 2013) for confirmation. For example, articles announcing the adoption of new laws in Maine confirmed findings using the LexisNexis search engine. Alternatively, discrepancies were noted in the case of Washington state where the EPA lists six Zone 1 counties but identifies seven on their map (Environmental Protection Agency, 2013). This however did not negate the overall findings of radon policy enactment in that state.

Next we created categories describing each state according to the presence or absence of state or local-level statutes. The categories were 0 = no statewide or locale policies related to radon resistant new construction, 1 = no statewide statutes but instances of local jurisdictions (i.e., city or county) adopting RRNC; 2 = statewide adoption of RRNC with local jurisdictions allowed local control over whether to adopt RRNC; and 3 = statewide adoption of RRNC with designations for which local jurisdictions must conform. All states fit into this organizational

framework except California where the radon policy is not governed through the building code, but rather through the public health department. As this divergence does not fit with any other state's RRNC procedures, they were not included in this analysis.

A Chi-square analysis was performed to test for an association between EPA risk designation and RRNC. States were dichotomized into high and low risk groups. A low-risk state was defined as having more than 50% of the counties designated by the EPA as moderate (Zone 2) to low risk (Zone 3). A high-risk state was defined as having more than 50% of the counties designated as moderate (Zone 2) to high risk (Zone 1). States were then further sorted on the presence or absence of any existing RRNC policy.

After analysis of trends in state and local level RRNC policy, qualitative interviews were conducted with affected building industry members and officials to gain a better understanding of the issues and concerns they experienced in their state when an RRNC policy was added to the building code. Subjective data from the telephone interviews were assessed for common themes using qualitative descriptions. From these interview themes a survey was crafted to gather the opinions of local tradesman in a region with high radon risk and no current RRNC policy. This survey was then administered to local tradesmen through the Southwest Montana Building Industry Association (SWMBIA) and through the Building Division office in Bozeman, Montana. Completion of this anonymous survey was voluntary.

The 20-item survey was a combination of multiple choice, Likert type scale and open-ended questions. Participation was voluntary and no identifying information was collected. Four questions were created to establish demographic information. Five of the survey items were used to establish level of trade and market affiliation of the participant. Five survey questions were used to ascertain current RRNC practice. The remaining six questions were crafted to explore

local opinion related to RRNC policy and practices. The questionnaire data were then entered into an excel spreadsheet for descriptive statistical analysis.

Results

The first aim of this study was to conduct a national inventory of RRNC policies in state or county-level statutes, laws or ordinances (see Figure 1). States colored in blue (category 0) indicated states where no policies had been adopted either at the state or local level ($n = 21$). Orange (category 1) indicated states where local policies in one or more counties or jurisdictions were adopted even though no state law had been adopted ($n = 19$). Red states (category 2) indicated adoption of RRNC at the state level with the provision that each jurisdiction/county had to vote to adopt the regulation at the local level ($n = 5$). In these cases, the state law was not a mandate. Finally, states colored green (category 3) indicated a state law that required high-risk counties to adopt RRNC. In these cases, local adoption was not optional for the high-risk counties or jurisdictions. California did not fit into any of these four categories as their state law requires the health department, rather than the building division, to implement RRNC. In this state, health department radon testing requirements must be met before a building permit may be granted. At the time of this writing, the California state law had not been operationalized.

The second aim was to test for an association of policy with high radon-potential areas as set forth as a goal in the HP2020 objective EH-15 (U.S. Department of Health and Human Services, 2010b). In order to complete an odds ratio (OR) analysis the states were separated into high and low risk groups. The states were defined as low risk when more than 50% of the counties were designated by the EPA as moderate (Zone 2) to low risk (Zone 3). They were defined as high risk when more than 50% of the counties were designated as moderate (Zone 2) to high risk (Zone 1). States were then further sorted on the presence or absence of any existing

RRNC policy. The odds were five times greater that states with more radon risk had adopted at least some level of RRNC compared to states with less radon risk ($\chi^2 = 2.34$, OR = 5.00, 95% CI 1.2 - 19.3, $p < .05$). While this is a descriptive analysis and includes states where only one or two counties have adopted RRNC in an overall high-risk state, the results indicate that the policy initiatives are directionally positive and associated with geographic risk.

The third aim was to survey local industry tradesmen in order to provide feedback as to current local practices and opinions on implementation of RRNC. Twenty-two individuals, all males, completed the project survey and reported their specialty in the following areas: general/sub contractor (n = 11), plumbing contractors (n = 5), electrical contractors (n = 2), and one HVAC contractor. Participants documented a wide range of years in the construction industry with an average of 10-20 years (range from <5 to > 20 years). Participants recorded the types of projects they typically worked on as single family homes (n = 19), custom homes (n = 19), speculation "spec" homes (n = 12), townhome/condominium projects (n = 11), multiple family homes (n = 8), subdivision/tract housing (n = 6), and commercial (n = 1). The average range for the market prices of the respondents' projects was \$200,000 - \$400,000 with some projects costing more than \$600,000 and none less than \$200,000. Respondents identified themselves as extremely (13.6%, n = 3), very (46%, n = 10), or somewhat (41 %, n = 9) knowledgeable on the subject of radon in building structures. No one reported having no knowledge at all. Respondents documented their educational preparation in the following range: high school/GED equivalent (n = 2), some college or trade (n = 8), completed 2-year degree (n = 3) to completed 4-year degree (n = 9). The majority of respondents were white

non-Hispanic with two respondents not reporting ethnicity and one not reporting race. One participant identified himself as Hispanic and one as Native American.

Participants next answered questions regarding RRNC in their work. Participants reported that their projects had radon systems installed always (n = 6), most of the time (n = 10), or occasionally (n = 6). The average cost of including a radon system to the project was estimated by six participants with a noteworthy range of responses (\$300, \$300 – \$800, \$800, \$1200, \$1500, \$2000, \$2000, \$1500 - \$2000, \$1500 - \$2500, and \$10,000). When installing radon systems, 18 reported using PVC pipes, 15 reported using a vapor barrier, and 14 reported installing exhaust fans. The terminology “PVC pipe” was used in the survey. Perforated PVC pipe is the more descriptive term to explain the piping used in RRNC. Two of the 22 respondents indicated “perforated” in their responses as an “other” method. These responses were incorporated into the total of 18 respondents reporting use of “PVC”. When participants were asked their reason for installing RRNC, 10 reported client preference, five stated local building practice, 11 reported builder preference, three stated local policy, 10 stated health and safety and three reported real estate value. When participants were asked, “How often do your clients express interest in having radon systems installed in their homes,” participants responded always (n = 1), often (n = 11), sometimes (n = 5), rarely (n = 3), and never (n = 1). Range of costs varied but could have been a function of interpreting the project costs as just to the particular specialist. Also, the high cost estimate was correlated to an individual who built very high-end homes.

The final section of the survey included questions for participants about their opinions on future RRNC policies. Responses to the question, “Should radon systems be

included in the building code” were split with nine in agreement and 13 against. If RRNC were adopted into the building code, three participants chose to adopt Appendix F, while five felt an alternative approach should be used. Most (n = 17, 77.3%) participants did not want to have a certified radon contractor for system installation. Participants indicated if radon systems were adopted into the building code a local building inspector should be used for system inspection (n = 11) or a state certified inspector (n = 3) should be used. Most participants (n = 14, 63.6%) did not think an exhaust fan should be mandatory equipment in RRNC. (The installation of an exhaust fan is the difference between an active and passive radon mitigation system.)

Table 1.

Participant Estimate of Current RRNC Approach by Method and Market Price of Project (n=10).

Construction Specialty	Estimated Cost to Project	Approach Used	Average market price in US dollars (x1000)
General/Sub	\$300	PVC, Vapor barrier & exhaust fan	\$200 - 400
HVAC	\$300 - \$800	PVC, Vapor barrier & exhaust fan	\$200 - 400
General/Sub	\$800	PVC, Vapor barrier & exhaust fan	\$200 - 400
General/Sub	\$1200	PVC & Vapor barrier	\$200 - 400
Plumbing	\$1500-2000	PVC, Vapor barrier & exhaust fan	\$200 - 400
General/Sub	\$2000	PVC, Vapor barrier & exhaust fan	\$200 - 400

General/Sub & Construction Mgr/ Real Estate	\$1500	PVC, Vapor barrier & exhaust fan	\$400 – 600
Sales/Real Estate	\$1500 – 2500	PVC, Vapor barrier & exhaust fan	All ranges
General/Sub	\$2000*	PVC & Vapor barrier	More than \$600
General/Sub	\$10,000	PVC, Vapor barrier & exhaust fan	More than \$600

*Passive system without fan.

Discussion

The first aim of this study was to conduct a national inventory of radon resistant new construction (RRNC) policies by state and county. We learned that the regulatory framework is diverse with at least five approaches to adopting policy. The least structured approach is a non-regulatory position, found in 25 states, with no state or local policy regarding radon reduction in new construction. Of the remaining states, 20 provide limited regulation with some local jurisdictions taking the lead and implementing their own policies when their states had not, while other states have adopted a state wide policy that local counties and jurisdiction must vote on to be utilized locally. The most selective approach to RRNC was established in four states where a statewide policy was used to regulate only the Zone 1 counties—those with average indoor radon levels at or above the EPA designated action level.

Not all states fit into the framework norm or fit into expected patterns of regulation. A unique approach to RRNC can be found in California. This state has partnered with public health in its bid to address indoor air quality. California does not have statewide or local jurisdictions with RRNC building codes. However radon testing and necessary mitigation plans based on test results must be submitted through the public health department and building permits are not

issued until compliance is met. The state of California has also reserved the authority to adopt any future Environmental Protection Agency RRNC standards prospectively unless the Department of Housing and Community Development adopts standards, in which case only the latter standards may be adopted (Environmental Law Institute, 2013).

Another standout in the policy framework is Florida. Florida implemented statewide RRNC into their building code despite the fact that the entire state is designated as EPA Zone 3. Recall that Zone 3 designation indicates low geographic risk for radon. While eight of the nine states with some level of RRNC adoption are high-risk states, the case of Florida suggests that perhaps factors apart from high-geographic risk lead some communities to adopt RRNC. Perhaps Floridians have high smoking rates and RRNC is one solution to improving indoor air quality and reducing lung cancer deaths.

The second aim of this study was to test for an association between geographic risk and existing policies. An odds ratio analysis of the differences in existing policies compared with geographic radon risk level revealed critical distinctions for future policy framework. The odds were five times greater that states with more radon risk had implemented at least some level of RRNC compared to states with less radon risk. It is important to recognize this is a descriptive analysis and includes states where only one or two counties have implemented RRNC in an overall high-risk state. However, the results indicated that the policy initiatives are directionally positive and associated with geographic risk. This demonstrates an increasing awareness in states where radon is prevalent.

Increased awareness however does not address health disparity in many cases. For instance in Idaho, a high radon risk state with 40.9 percent and 47.7 percent of counties in EPA Zones 1 and 2 respectively, RRNC policy has been passed only in high income pockets around

ski resort towns. The majority of its rural counties have not enacted nor can they generally afford the infrastructure required for increased code requirements. This is a cause for discussion of risk-based or statewide policy in efforts to avoid increasing health disparity predicated on socioeconomic status.

The third aim of this study was to administer a survey to building industry members to attain their perspectives on a local RRNC policy. In order to make the most promising attempt at a state response to the HP 2020 objectives and the reported trend, it is important to hear the voices of those Montanans who would adopt an RRNC policy and bear the weight of its costs in this state.

Analyses of interviews with industry members in other states that have adopted statewide RRNC reveal differing themes on the success of the program. Themes varied depending on industry member role. Building officials reported the program a success while industry members in the field find the new codes ineffective and prohibitive. Additionally industry tradesmen reported fewer construction projects with RRNC in place than before the policy adoption due to “loopholes.” These opinions are anecdotal but attest to the difficulty of adopting useful and effective policy without engaging appropriate industry members who would bear the weight of implementation.

While survey results were limited in number, generalized implications toward local viewpoints can be drawn from the data. Almost two dozen local industry members (n=22) reported that their projects included installation of radon systems at least occasionally with 72.7% (n=16) stating that most or all projects included a radon system. The common practice of installing radon systems in new homes is indicative of both industry awareness and client preference. Survey results showed respondents identified themselves as

extremely (13.6%, n = 3), very (46%, n = 10), or somewhat (41 %, n = 9) knowledgeable on the subject of radon in building structures. No one reported having no knowledge at all. When asked the reason for installing radon systems a majority of respondents indicated client and/or builder preference as well as health and safety concerns. Additionally 52% of survey participants indicated clients often expressed interest in having radon systems installed in their homes. Despite the common practice of installing radon systems, respondents were divided on the issue of incorporating an RRNC policy into the Montana Building Code.

In the next phase of research the variety of approaches implemented by states where RRNC has been adopted need to be shared with stakeholders in Montana. This information is important to share as it may facilitate next efforts toward an ultimate goal of utilizing members of the building industry as public health partners in adopting an RRNC policy. It would be ideal to collaborate with all of the partners—public health officials, tradesmen, building inspectors, and regulators to adopt a policy that has buy-in from all of the vested parties.

Limitations

A limitation of this study was the limited location and sample size for specific aim 3. The locality of this study is a microcosm of higher income and housing market price that does not necessarily convey to the state as a whole. While Southwest Montana maintains a rural designation, it is surrounded by two ski resorts and a university which has created an area with high real estate and housing costs. In terms of the small sample size, the lack of survey results may indicate a methodological error or a lack of interest in RRNC within the membership of the local building industry. A small incentive for survey-based research is a typical way to engage

participants that was not employed in this study due to budgetary constraints. Despite these limitations, this study is one of only a few to examine local industry perceptions and current practices in RRNC as it relates to Healthy People 2020 objectives.

Conclusions

Residential radon exposure presents a significant health risk. Health care and environmental health have similar professional values such as disease prevention and social justice. Nurses are responsible for addressing the environmental hazards that present a risk for their patients and community. As the population continues to age, adverse health effects from radon will continue to increase without a successful program to reduce exposures. Several cost/benefit analyses have clearly indicated mitigation of existing homes along with adopting RRNC systems can be justified on a national level. High-risk states can and are setting precedent by addressing some of these issues through building code and policy. It is imperative as we move forward to create a policy that is evidence-based and informed by local industry members in order to create the changes that will result in improved indoor air quality and improved health.

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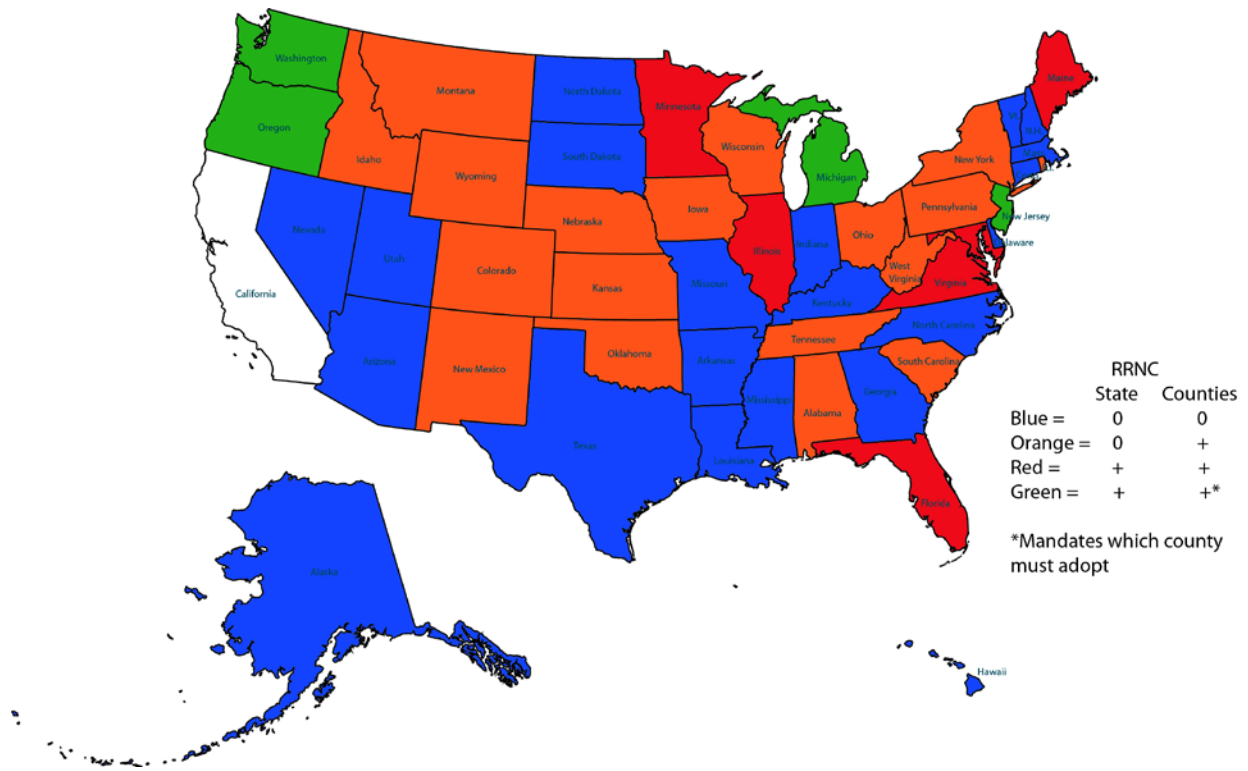


Figure 1. United States map of existing RRNC policy

State	RRNC*	% Zone 1	% Zone 2	% Zone 3	RRNC	At Risk	Sum - Zones 1 & 2
DC	0	0	0	100	No	Less	0
HI	0	0	0	100	No	Less	0
LA	0	0	0	100	No	Less	0
MS	0	0	9.8	90.2	No	Less	9.8
OK	1	0	11.7	88.3	Yes	Less	11.7
FL	2	0	13.4	86.6	Yes	Less	13.4
TX	0	0	15.4	84.6	No	Less	15.4
AR	0	0	18.7	81.3	No	Less	18.7
SC	1	2.2	17.4	80.4	Yes	Less	19.6
AK	0	0	24	76	No	Less	24
DE	0	0	33.3	66.7	No	Less	33.3
GA	0	2.5	34.6	62.9	No	Less	37.1

NC	0	8	31	61	No	Less	39
MI	3	10.8	38.6	50.6	Yes	Less	49.4
WA	3	17.9	35.9	46.2	Yes	More	53.8
OR	3	0	58.3	41.7	Yes	More	58.3
MD	3	33.3	33.3	33.3	Yes	More	66.6
AL	1	19.4	49.3	31.3	Yes	More	68.7
VA	2	45.9	23.7	30.4	Yes	More	69.6
TN	1	40	33.7	26.6	Yes	More	73.7
NY	1	54.8	21	24.2	Yes	More	75.8
RI	2	40	40	20	Yes	More	80
NE	1	57	25.8	17.2	Yes	More	82.8
NJ	3	33.3	52.4	14.3	Yes	More	85.7
VT	0	0	85.7	14.3	No	More	85.7
CT	0	50	37.5	12.5	No	More	87.5
ID	1	40.9	47.7	11.4	Yes	More	88.6
WV	1	36.4	52.7	10.9	Yes	More	89.1
MA	0	21.4	71.4	7.1	No	More	92.8
KY	0	25	68.3	6.7	No	More	93.3
MO	0	84.3	9.6	6.1	No	More	93.9
NV	0	52.9	41.2	5.9	No	More	94.1
IL	3	54.9	42.2	2.9	Yes	More	97.1
PA	1	73.1	25.4	1.5	Yes	More	98.5
AZ	0	0	100	0	No	More	100
NH	0	10	90	0	No	More	100
UT	0	24.1	75.9	0	No	More	100
IN	0	62	38	0	No	More	100
SD	0	72.7	27.3	0	No	More	100
ND	0	100	0	0	No	More	100
NM	1	21.2	78.8	0	Yes	More	100
WI	1	38.9	61.1	0	Yes	More	100
OH	1	60.2	39.8	0	Yes	More	100
KS	1	61.9	38.1	0	Yes	More	100
CO	1	80.6	19.4	0	Yes	More	100
MT	1	87.5	12.5	0	Yes	More	100
WY	1	91.3	8.7	0	Yes	More	100
IA	1	100	0	0	Yes	More	100
ME	2	75	25	0	Yes	More	100
MN	3	78.2	21.8	0	Yes	More	100

Appendix 1. Existing RRNC policy versus Environmental Protection Agency zone designation with odds ratio.

*0 = no state or local RRNC policy; 1 = no state but some local RRNC policy; 2 = state RRNC policy with local choice of adoption; 3 = state RRNC policy that selects for specific high risk areas

The Kinematics of Slope Style Skiing: Dominant vs. Non-Dominant Rotations in Professional, INTERMEDIATE & BEGINNER Level Athletes

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ABSTRACT

Skiing is a sport that encompasses a broad range of disciplines. Slope-style skiing consists of “terrain-park” and “urban” features in which athletes perform spins and flips off of jumps and grind rails on their skis. Most resorts have professionally built “freestyle terrain-parks” designated for these free ski athletes. These features range in difficulty levels from “beginner to advanced,” and complications arise when athletes attempt tricks that are too advanced for the skill levels. In terms of going off of jumps, riders perform tricks such as 180°, 360°, 540°, 720°, 900° rotations. Athletes often go inverted and “off-axis” in many of these tricks, performing backflips, flat-spins, double spins, and even triple spins. This sport is growing rapidly with children as young as 11 years old entering the competition scene at a professional level, and it has recently been accepted into the Winter 2014 Olympics. Because of this, it is crucial that researchers begin investigating and exploring the kinematics, kinetics, and other factors that are required to successfully execute and safely land these tricks. An exploration of some of the most basic factors involved in executing a 360o rotation in an athlete’s dominant and non-dominant directions of rotation will yield useful data for freestyle coaches, teams, and athletes because it will provide a foundation for identifying each athlete’s strengths and weaknesses, and will allow coaches and/or athletes to begin implementing drills and techniques to build the athlete’s skills. These skills are necessary for all slope style skiers to master before further progression can occur.

INTRODUCTION

“With the increasing popularity of freestyle skiing and snowboarding, many ski resorts have constructed their own terrain parks including several jumps, rails, and pipes. In order to prevent risks of high-impact injuries in jumping, an adequate construction of the landing hill is very

important.” (Bohm, 2007). These features (i.e. jumps, rails, halfpipes, etc.) range in difficulty levels from beginner to advanced, and complications arise when athletes attempt tricks that are too advanced for the skill levels. In terms of going off of jumps, riders perform tricks such as 180°, 360°, 540°, 720°, 900° rotations. Athletes often go inverted and “off-axis” in many of these tricks, performing backflips, flat-spins, double spins, and even triple spins. As the complexity of these tricks increases, it becomes clear that the rider is at an inherently higher risk for sustaining injuries if the proper skills and techniques are not mastered prior to attempting the trick. Further, proper maintenance and building of these features rely heavily on the expertise of the terrain park staff of the ski resort. Because errors in building are often a likely possibility, signs are placed at the entrance of the parks to inform riders that they perform and attempt tricks/features at their own risk, and also remind them to “start small” and work up to more difficult features. *The purpose of this research was to describe the kinematic factors involved in executing a very basic trick, a 360° rotation, in both the clockwise and counter-clockwise directions, one being the dominant, or preferred, direction of rotation for the athlete, and the other being the non-dominant, un-natural direction of rotation.*

Skiing and snowboarding injuries sustained in terrain parks compared to those sustained on traditional slopes, specifically head and spine injuries, have been found to be higher and more severe (Brooks, 2009). One of the primary reasons for this may be due to the lack of experience and mastery of these basic skills before performing larger tricks, especially off of larger features, which have an inherently higher risk due to greater velocities and higher vertical distances from the landings. Progression that occurs too quickly without a solid foundation of basic skills can cause serious injury and/or death to athletes. As the skill levels of the tricks become more and more technical, a higher level of risk accompanies the sport, and therefore the athlete. As a result, an exploration of some of these basic factors involved in executing a basic 360° rotation will yield useful data for freestyle coaches, teams, and athletes because it will provide a foundation for identifying an athlete’s strengths and weaknesses, and will allow coaches and/or athletes to begin implementing drills and techniques to build the athlete’s skills. In this way, slope style athletes, especially those working to build on their most fundamental skills, can fully understand the kinematic factors required to perform the most basic tricks. Mastery of these skills is necessary for the athlete before moving on to further progression of tricks. The winner of the 2013 winter X-Games big air competition, Henrick Harlaut, successfully executed and landed the first ever “nose butter triple cork 1620,” making history. This trick involves going inverted three times while simultaneously rotating a total four times – it is highly complex and involves a difficult set of skills. As a professional athlete, Harlaut started skiing at two years old, and is now 22 years old. In this way, professional athletes serve as role models to many aspiring skiers because they have spent a great deal of time learning the basics, and from there were able to build their skills to push the sport to the high level it is at today.

This research examines the importance of “starting small” and building a solid skill foundation before progressing on to larger and more difficult rotations and inverted tricks off of ski jumps. It was found useful to test these kinematic factors among three distinct slope style athlete levels – a professional athlete, an intermediate athlete, and a beginner athlete. In this way, comparisons and differences were able to be observed among the data. The data were then able to be analyzed and used as a resource to help coaches and athletes safely progress through learning tricks.

METHODS

Before beginning any research, approval from the International Review Board (IRB) was obtained. A detailed summary regarding the specifics of the procedures used in the experiment was written, including all safety procedures that would be implemented. A letter from the Bridger Bowl Ski Area was also obtained that explained that they knew of the research being conducted in their professionally built terrain park. Each athlete signed a waiver which informed them of the rights and that their participation in the research was voluntary and at their own risk.

On March 8th, 2013, athletes and researchers met at Bridger Bowl Ski Area terrain park near Bozeman, MT to perform the experiment. The athletes were allowed to take two warm up runs in the terrain park to allow them to get used to the overall feel of the jump. A shadow box accelerometer was then programmed and securely attached to each skier's left ski behind the heel binding via duct tape. It was used to measure the velocities and spin rates generated by each athlete at various points in performing the trick. Data was collected at a sampling frequency of 100 Hz.

The temperature at the time of the experiment was 30° Fahrenheit. The terrain park jump was considered a “small to medium” jump at 3 meters (10-15ft) in vertical height. It was built and maintained by the experienced terrain park crew at Bridger Bowl, and at the time of the experiment, the jump had been freshly groomed, and the snow was hard packed and fast. The in-run to the jump was 25 meters long. Both the in-run and the landing of the jump had smooth and hard packed snow.

Both the professional and the intermediate athletes performed two 360° rotations in their dominant direction (counter-clockwise) as well as in their non-dominant direction (clockwise). The beginner athlete performed the rotation only in the dominant direction (clockwise). After the data collection was complete, the data was downloaded to the computer using the Ride-

Tracker software. The data was then analyzed to determine each athlete's take-off velocity, deviation velocity, and initial z-spin rates in the transverse plane of rotation.

Both the professional and the advanced athletes performed three 360° rotations in their dominant direction (counter-clockwise) as well as in their non-dominant direction (clockwise). At the top of the jump, each athlete's skis were removed and dried as thoroughly as possible using paper towels. Next, a hand was placed over the ski to help warm it up, so that the duct tape would stick better to it. Then the accelerometer was carefully and securely attached to the ski just behind the back of the left ski binding. Next, the accelerometer was turned on and the rider's name was selected. Before dropping into the jump, the athlete lifted his leg up and down quickly, so as to mark the start of his descent. Then, the athlete dropped into the in-run of the jump, gained speed, and performed a 360° counter-clockwise rotation in his dominant direction (to the left). Upon landing the trick, the device was turned off, and the rider hiked back up to the top of the in-run for the second jump. The same procedures were followed for the next rotations, however, the spin was performed in the clockwise direction (right), which in this case was the athlete's non-dominant direction of rotation. Next, the intermediate athlete performed his two rotations following the same procedures, followed by the beginner athlete. The beginner athlete performed a 360° clockwise rotation (right), which in this case was her dominant direction of rotation, opposite the other two athletes. However, she did not perform the counterclockwise (non-dominant) rotation because she was uncomfortable executing the trick in this direction. Each athlete performed one more rotation in each direction, providing two trials for each spin to account for possible errors that may have occurred in the first trial.

The data were then uploaded into the computer system via ride tracker software and data was recorded for the Z-Spin Rate, which consisted of the rotational, side-to-side (mediolateral) spin rates. The athletes' initial take off velocity and deviation velocity were recorded. The deviation velocity marked the point at which the athlete began to set, or wind-up, for the spin at the moment before leaving the jump. The maximum vertical distance, or peak-height, reached during each rotation was also recorded.

Finally, the data was analyzed and comparisons were made between the dominant directions of rotation in each case, between the non-dominant rotations, and between both the dominant and non-dominant rotations for each individual athlete. Then, comparisons of the data were made among the athletes and the differences were noted.

RESULTS

KINEMATICS OF PROFESSIONAL, INTERMEDIATE, AND BEGINNING FREESKI ATHLETES

Athlete	Direction	T.O. Vel (m/s)	Deviation Velocity (m/s)	Initial Z-Spin Rate (°/sec)	Max Ht (m)
PRO	CCW	15.1	15.3	279.3	4.0
	CW	11.2	12.1	124.8	4.0
INT.	CCW	14.7	14.6	285.0	3.35
	CW	10.3	8.4	404.9	3.87
BEG	CW	11.2	7.5	462.8	1.76

TABLE 1: Counterclockwise vs. Clockwise Rotations in Professional, Advanced, and Intermediate Level Athletes.

CCW – Counterclockwise Rotation CW – clockwise rotation

PRO – Professional Athlete

INT – Intermediate Athlete

BEG - Beginner Athlete

DISCUSSION

Overall, an inverse relationship was found between a skier's deviation velocity and their initial Z-spin rate. This was easily observed in the beginning athlete, in which data was recorded only for the dominant (clockwise) direction of rotation. It was found that the initial velocities were low and the spin rate was high to compensate for the lack of air time off of the jump. When compared to the velocities and spin rates of the intermediate and professional athletes, the beginner athlete's deviation velocity was much lower and had the highest spin rates. As a result of this slower deviation velocity, the maximum height reached off of the jump by the intermediate athlete was much lower than that of the intermediate and professional athletes.

This was significant because it suggested that the beginning athlete may tend to have lower levels of confidence in executing a basic 360° rotation, even in the dominant direction. Therefore, they may not take as much speed into the jump and will therefore have less air time (less vertical height) off of the jump, and must compensate for this by having a very fast spin

rate so as to land the trick in a shorter amount of time. Athletes and coaches can use this information to practice building confidence off of jumps before athletes even attempt a spin. By “straight airing” the jump several times to *feel* for the right speed, athletes can feel safer and more confident about safely landing their spin because they will have a comfortable amount of air time and won’t have to huck their spin as hard to get it around in time. Hucking a spin can be dangerous for the athlete because it means they have more torque with their bodies, and if they land too high up on the landing or do not complete their spin, they have a higher chance of sustaining an injury such as an ACL tear in the knee.

When each individual athlete’s dominant and non-dominant rotations were compared, the data showed that both the intermediate and professional athletes’ take-off and deviation velocities tended to be faster when they approached the jump and prepared to spin in the *counterclockwise* direction, which in both cases was the athletes’ dominant direction of rotation. Similarly, the initial Z-spin rates tended to be lower for these rotations, indicating that there was a higher level of confidence for these athletes as they performed the rotation in their dominant direction.

Conversely, when the intermediate athlete approached the jump and prepared to execute the rotation the clockwise (non-dominant) rotation, the initial and deviation velocities were found to be slower than those of the counter-clockwise (dominant) direction. This indicated that there was likely more stress in performing the rotation in the non-dominant direction. However, the professional athlete’s initial z-spin rate was actually slower than his spin rate for his dominant rotation. This difference suggested that the professional athlete was perhaps more confident or equally as skilled in executing the rotation in both directions.

APPLICATION

This data suggests that even athletes at the highest levels of slope style skiing understand that there is an inherently higher risk in performing tricks in the non-dominant directions. This is why at competitions, un-natural tricks score higher points – although they are the same trick, they are more difficult in the opposite direction. It is crucial that coaches and athletes of all levels, especially beginning/intermediate athletes, understand this concept so that they can identify their athletes’ dominant sides, master those, and then work them through the appropriate progressions to learning the trick in the opposite direction; in this way, they work to ensure their safety and reduce their risks for injuries as they progress and learn new tricks. Techniques and drills to develop skills are up to the discretion of the athletes and/or the coach(es), but some common examples may be having the athlete(s) straight the jump and practice “popping” higher off the lip, practicing grabs in the air to work on body control and

awareness in the air, and having them perform the trick with different grabs or in simpler steps (i.e. a 180 first, then a 360). It was clear that the beginner athlete in this research had not perfectly mastered a 360 in her dominant direction – she had to huck the spin and did feel extremely comfortable going fast off of the jump. Thus, she should continue to work on these skills, perfect them, and then move on to trying the trick in the un-natural direction.

By exploring the kinematics of slope-style skiing, coaches and athletes can begin to have a better understanding of safe progression and of the importance of taking all of the proper steps to learn a basic trick before moving on to more advanced tricks. The data yielded in this experiment may prove especially beneficial to those coaches who are active in training younger skiers who are just beginning to build a foundation of their skills. It can be difficult for athletes who desire to compete at intermediate or higher levels and who just want to move on to the harder, more “fun” tricks; this can be very dangerous if the athletes have not had the proper training and taken the right steps to build their skills and perhaps more importantly, their confidence. Building this foundation of performing basic tricks is important for athletes who wish to further their skills and who hope to compete in competitions, and also to ensure their safety. If athletes try to progress too quickly through skills, they have a higher risk of making errors and of getting injured.

FURTHER RESEARCH

Further research in this field may consist of exploring more advanced tricks, such as inverted flips or off-axis (corked) spins. As these athletes continue to reach higher skill levels, their risk of injury increases because not only are the tricks more difficult and complex, but higher velocities and much bigger jumps become involved. The importance of understanding these basic kinematic factors is clear.

In addition to exploring the more basic kinematic factors involved in performing these tricks, a more in depth exploration of the kinetics and forces involved in successfully executing these tricks, both basic and complex, can prove especially useful because athletes and coaches can have a better understanding of the specific actions and reactions that must occur and in what ways to ensure proper execution and landings; this would further work to promote and enhance their safety.

Aside from exploring the specific kinematic and kinetic factors that the athlete must generate and work with, research examining the specific builds and conditions of the jumps and features may prove especially beneficial. Making sure these jumps are at the right angles and that their in-runs and landings are long enough for the athletes to generate enough speed to clear the flat

zones and land safely on the landing and at the right angles is also a very important safety factor for all slope style athletes.

Overall, the sport of slope style is becoming increasingly popular, and we recently saw these amazingly talented athletes compete in the 2014 Winter Olympics. Many of the tricks that these athletes perform are so incredibly complex, such as the “switch nose butter triple cork 1620°” that was performed for the first time ever in the 2013 Winter X-Games Big Air event. These athletes continue to push the limits of human physics, and to explore these mechanisms to promote the safety of the athletes is at the very least a justice to human biomechanics.

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An Analysis of English for Scientific Purposes Methods in the Middle East and its Presence in the STEM (Science, Technology, Engineering and Math) curricula

Abstract:

With globalization becoming the natural trend in today's world, the need for STEM (Science, Technology, Engineering and Math.) focused majors in the United States' higher education is becoming more apparent. According to Congress, the economy depends on the increase of the amount of STEM careers for America to once again become competitive with other achieving countries. With only 17 percent of degree distributions focused in STEM, there is a lack of accredited scientists and engineers in the United States to compete with other leading countries like Japan (64%) and China (52.1%). English for Scientific purposes under the English for Specific Purposes language curriculum has become the forefront pedagogical method for other countries to prepare their students. The international classroom and laboratory is becoming a more English dominated field. Six English-fluent students in STEM majors from all over the Middle East were interviewed to discern their experience learning English and selecting their major. The students had to answer questions that inquired about their English studies, their STEM studies, reasoning for selecting STEM, and if they have worked in lab. An analysis of the patterns found among these students has been conducted based on their motivations, experiences, and contributions to the scientific world. The students created many interesting connections between helping people and the pursuit of a STEM major. The students utilized a variety of sources in their studies with varied learning methods.

The STEM dilemma

The United States has recently addressed its ranking in STEM topics worldwide, and the results are not preferable for a competitive standing. The inconsistencies have created a gap in STEM education that seemingly creates a roadblock in the STEM related job market. This roadblock becomes larger as more qualified candidates are coming from overseas. Handling it is a difficult task because many of the countries that are above the U.S. in ranking do not have English as their first language, but nevertheless do much of their research, and publishing in English.

The statistics are startling and the importance of America's place in STEM is quickly becoming more apparent. According to the Congressional report prepared in 2008, "The U.S. ranks 20th among all nations in the proportion of 24-year-olds who earn degrees in natural science or engineering." With only 17 percent of degree distributions focused in STEM, there is a lack of accredited scientists and engineers to bring up the United States' statistics. (Kuenzi, 2008) Comparatively, the top competitors displaying a higher ratio of STEM degrees percentage-wise in 2006 were Japan (64.0%) and China (52.1%). For reference, the U.S.'s numbers did not match anything near as high at 16.8 % (National Science Foundation, 2006.) The problem is apparent, but the strategy to promote a change must be be officiated by Congress.

The National Science Board prepared a report in 2010 on the state of America's STEM education. The publication was titled "Preparing the Next Generation of STEM Innovators: Identifying and developing our Nation's Human Capital." This report introduced the idea that future STEM participants are "innovators" depended upon by our nation. These innovators are defined as "Individuals who have developed the expertise to

become leading STEM professionals and perhaps the creators of significant breakthroughs or advances in scientific and technological understanding.” (National Science Board 2010) This notes how heavily we rely on these students in the future and creates a sort of appeal to the “label” in an attempt to increase the number of STEM majors. The idea of being an “innovator” for American comes off as highly attractive.

With this definition in mind, the report suggests three areas of focus for the future, first more “policies and practices.” Secondly “commitment to equity and diversity” which means utilizing a more varied demographic in the search for the next “innovators.” Finally, a “learning environment infused with high expectations and a commitment to excellence.” This final focus suggests that current standards are not high enough to compete, and this area of education must soon surpass International competitors (National Science Board 2010.)

There are many differing perspectives on this “STEM dilemma,” but the collective goal is acquiring a higher percentage of Americans in the STEM field with a more qualified educational background in their subject. This can be done in many ways, but the main suggestion put into play is “the replacement of traditional lecture based, teaching strategies with more inquiry and project based approaches” (Breiner et. Al. 2012.) This method is great from an educational perspective. Creating differentiation in the classroom and can play into all learning strategies. The more hands-on learning also reflects what these students will be doing in their field as a scientist or Engineer.

The Economic perspective cannot be ignored among the multitude of reasons for improvement. With almost 3 billion dollars of funds appropriated for STEM education in 2010, the money was funneled into 209 programs with budgets between “\$15,000 and

hundreds of millions.” (Scott, 2012) Although “the global economy is not a zero-sum-game” the need for the United States to be prepared can assist with “prosperity in in a time of unprecedented global competition.” (Bybee and Fuchs, 2006) A concrete standing in the global economy is integral to being a worldwide power.

Thoughts on English for Scientific Purposes

English for Scientific purposes is a Division of English for Specific purposes educational curriculum. Strevens notes that the nature of this pedagogy specifies in terminology and other scientific language for success in a STEM field. These specific topics are not necessarily the focus in a standard ESL (English as a Second Language) curriculum. (1988) The “specific learning context” designed to “meet the needs of the learner” is the main idea of English for Specific Purposes and this specificity is important for assimilating into the working world. (Johns and Dudley-Evans 1991) With this in mind, the specificity of this curriculum allows non-native English speakers to share their published work internationally and in a manner understood by their peers. (Flowerdew, 1999).

As noted in “New Trends of English Teaching in Outstanding Engineers’ Education” the current state of general English as a Foreign Language curriculum does not focus on a specific technical specialty. In a technologically advanced world globalization is the necessary proponent for movement forward. The author, Zhang, describes the different benefits of “Global Engineering Excellence.” (2011) He notes that “International safety” and “continuous development” are imperative for dealing with global issues. A drive for globalization is also sustained by the effectiveness of collaboration; information is best shared over the greater international network. This

makes friendly partnership a priority, along with increased efforts for technological networking for shared information (Grabe, 1988.)

To understand Grabe's ideals involving technology one must acknowledge English as an "umbrella" language in on the world stage. English encompasses the research world as a baseline default. Using English across the board facilitates "information access, technology transfer and economic development." On the other hand, Grabe also touches on the imperialistic overtones of English being the main choice, but falls back upon the reasoning that progress is more prevalent with the use of English (1988.) The use of "English as a International language of science" is progressive for flexibility between cultures. Flowerdew notes that many of the most prestigious research databases publish in English "For scholars who want their work to be read (and cited) widely by their international peers, publication in such journals (this) is essential." (Flowerdew, 1999.)

Collecting the Data

A standard survey was composed and distributed to six STEM focused students. Their majors spanned from microbiology to medicine to Computer Engineering. This survey focused more on the Science, Technology and Engineering aspect of STEM. The math component was unfortunately absent. These students were interviewed and hand selected to participate in this specific leadership program. The students were chosen based upon their qualifications and enrollment in a university of his/her Native country. There was no time limit on the survey and the students were encouraged to ask questions

to clarify any misunderstandings. The participants were eager to complete the survey, and they all answered the questions to the best of their ability.

The survey contained 34 questions that touched on a variety of topics. (See Appendix) These topics focused mainly on their experiences learning English for scientific purposes. Learning styles, lab experience and other relevant educational background information was covered as well.

The three main questions that summarize the survey:

- Have you ever felt that learning English assisted with your studies or research? If so, please describe why if at all possible
- How did you decide to choose a STEM focused major?
- Have you ever taken a STEM (Science, Technology, Engineering and Math) based class that was taught entirely in English?

Summarized Results from the Survey:

Student (#)	First Language	STEM area	Years of English	Lab experience?	Language in lab	Published?
Student 1	Arabic	Science	3	No	N/A	No
Student 2	Arabic	Science	13	Yes	Partial English	No
Student 3	Arabic	Science	14	Yes	English	Yes
Student 4	Arabic	Science	7	Yes	No English	No
Student 5	Arabic	Engineering	~10	Yes	English	No
Student 6	Arabic	Engineering	14	Yes	English	No

Caption 1: This table gives a general outline of the student's information provided by the survey.

General Feedback from the Survey

The range of answers from the participants was particularly interesting phenomena. The motivations were very similar and they all emphasized the use of English in their home countries with Arabic as the native language. Almost all of the

participants had been learning English for over 10 years, and English was the main language he/she used to explore each respective STEM topic. It was expressed that any and all Math, or terminology classes were taught mainly in English. This connects back to Flowerdew's ideals about English as the "dominant language." English has been interwoven into their education as a useful tool.

In a research setting, only one lab omitted the use of English, and another utilized partial English. This left a majority as English only labs. There were no students who majored in math, so STEM was not entirely represented. The two Engineering students were both Computer Engineers, so Technology was present along with a minimum design aspect of engineering.

The students identified their main resources for English learning to be more conversational resources, than formal resources. Scholarship opportunities and programs took precedence as integral resources that were preferential in their undertaking of the English Language. One student cited her country's Institute for Scientific Research Program as a significant resource for her English Education. Another students cited one program in particular, AMIDEAST. As described on its website, "AMIDEAST is a leading American non-profit organization engaged in international education, training and development activities in the Middle East and North Africa." According to the description, AMIDEAST allows students to "develop language and professional skills critical for success in the global economy" (AmidEast, 2013.) This creates an interesting dynamic as an American program has been cited as an influential resource for international students in STEM.

Casual resources were specified in a variety of forms. Google Translator was identified as a useful tool, as with many of their products and opportunities the company provides. A few participants cited American television, films, and music as a useful tool to understand social context for English. One student felt that the use of an American instructor was critical because “(he/she) introduced (him) to a new, integrative way of learning.” Finally, the use of conversational partners was highlighted as a baseline method for practicing English.

Why STEM?

Many of the students interviewed were passionate about their respective topics, and had a strong sense of leadership in the acquisition of his/her degree. The general response was that helping people, and following their passion was the core motivation. One student claimed, “I always dreamt of being a Computer Engineer, I like this career and it is my joy in life.” Another student in Computer Engineering stated, “I love it, and because I want to make a change to community.” Finally, another student felt that a STEM focus in Pharmacy offers a great future. He decided to choose STEM because of “(his) passion for chemistry and job opportunities available in (his) country.” Overall the participants were enthusiastic about their majors for reasons that are mainly rooted in the world around them.

Student 3

Student Three is a very unique participant in this study. The highlighted student was the only participant who had lab experience and was published while working in a lab. His amount of experience stands out among his peers as exemplary. It was interesting that this student felt more comfortable with a different learning style than his peers. This

student cited that he liked to work alone, and the advancement of his career was based upon the terminology and technical knowledge that accompanied the curriculum rather than the use of English itself. A Pre-Med student, the student chose this major because “(He) was inspired by people in the field that wanted to improve scientific progress and research.” This focus on research was most likely what assisted with the publishing of his medical findings.

Student three is set apart from his peers because he finds success in English by using only technical tools and opportunities. As many other students mentioned, the use of casual, conversational tools was incredibly valuable for their experience. Student three says he preferred Professional English, and Scientific methods and terminology have always been integrated into his education.

The Middle Eastern Perspective of English

The collective message portrayed by these students clearly demonstrated that English is an integral part of their education. All but one of their home countries required English from a very young age in all subjects. The students did specify a few programs that assisted with their studies as described in the “General Feedback from the Survey” section. Interestingly enough only two students were enrolled in a course for “English for Scientific Purposes.” One student found it more useful than a grammar based class. The other student claimed that it was not very effective, and most of his education in the past had already been integrated with science. With ESP cited as an effective pedagogy, it could be assumed that its use would be more widespread.

Conclusions

With a noticeable gap of research focusing on the Middle East, this survey utilized the privilege of having an incredible group of young, ambitious leaders at the University. All of the students reiterated that they were pursuing their career paths because they want to help people; they love the material of the topics, and were inspired by the impact STEM topics have on our ever-changing world. This program was a useful tool for the participants, and from the survey data, the use of these socially rooted programs continued to promote and support the participants.

Looking forward, the need for diversity in this “disproportionately white and male” population of STEM participants could be a continuing focus. (Seymour, 2001) Although the United States has fallen behind in the global competition, a greater effort should be applied toward diversifying in the race and gender of STEM focused citizens (National Science board 2006.) The funded resources guided toward STEM should be seen as an opportunity and should be utilized by all students interested in a STEM future.

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Appendix:

Survey for “An analysis of English for Scientific Purposes Methods in the Middle East
and its presence in STEM curricula”

Thank you for participating in this survey, all material from this questionnaire is anonymous and the answers will not be shared. Participation is voluntary, and you can choose to not answer any question that you do not want to answer, and you can stop at anytime. If you have any questions at all, please do not hesitate to ask.

1. What is your major, or area of study? _____

2. What country are you from? _____

3. What is (are) your native language(s)? _____

4. How long have you studied English? _____

5. What was your reasoning for choosing English as a foreign language?

6. While learning Scientific English were there any specific programs that helped with the process? If so please describe below:

7. While learning Scientific English was there any specific tools, or methods you used to help? If so please describe below. For example; conversational partners, learning strategies, online programs, etc.

8. Do you think these tools effectively assisted with learning Scientific English? How so?

9. Have you ever felt that learning English assisted with your studies or research? If so, please describe why if at all possible

10. Have you ever taken an “English for Specific (or Scientific) purposes” class?
(Circle One)

Yes No

11. If you answered yes to question 10, do you think the strategies in this class were more effective than a grammar based class? If you answered No, would you say that your classes are traditional grammar based classes?

12. Have you ever taken a STEM (Science, Technology, Engineering and Math) based class that was taught entirely in English? (Circle One):

Yes No

13. If you answered yes to question 12, please give detail about the nature of the course if at all possible.

14. If you answered yes to question 12, was the coursework made up of material that had not been previously taught in your native language? (Circle One)

Yes No

15. If you answered yes to question 14, was it difficult to learn new material entirely in English? Please go into detail below:

16. Have you ever felt the presence of a language barrier in your scientific research, or studies? (Circle One)

Yes No

17. If you answered yes to the question 16, please give more detail if at all possible.

18. Do you find that working in groups is more beneficial than working alone while studying, or writing in English?

19. Do you feel that STEM (Science, Technology, Engineering and Math) careers are a common study focus choice in your University?

20. How did you decide to choose a STEM focused major?

21. Have you ever worked in a lab, or in your field of study? (Circle one)

Yes No

22. What was the general focus topic of the field work or lab (or labs) that you have worked in?

23. Was English spoken or written in your field/lab work in either a casual, or professional manner?

24. Has your work ever been published in a research journal? (Circle One)

Yes No

25. If you answered yes to question 24, was your research published in English? (Circle One)

Yes No

26. If you answered yes to the previous question did you find publishing in English to be difficult? How so?

27. Why have you chosen the field or career path you have?

28. How did you transition from everyday conversational English' to discipline-specific (or academic) English? Did you notice a particular time when you were required to learn it?

29. Were you ever enrolled in a class when you learned scientific or engineering terminology? (Words related to your field of study)

Yes No

30. What was that class called and what was the class about?

31. What Materials did you use in your classes? What textbook? What resources? Name them please if at all possible.

32. How did your English study prepare you for using research texts and textbooks?

33. What could have helped you more in your English studies?

Alyssa Sandner, McNair Scholar
Dr. Jioanna Carjuzaa and Janelle Rasmussen, McNair Faculty Mentors

34. Did you ever have an American instructor? If so, what was that like?

Site Directed Mutagenesis of Rotavirus NSP1 strains OSU (porcine) and W161 (human) to further understand cellular and viral interactions.

Alyssa Sandner, Biotechnology of Animal Systems

Montana State University

Michele Hardy, Ph.D., Mentor

Department of Immunology and Infectious Diseases

ABSTRACT

It is well known that the Rotavirus strain NSP1 causes the degradation of specific immunoregulatory factors (Arnold and Patton.) The specificity of this degradation depends on the living target at hand (Porcine, Bovine, Human.) Interferon regulatory factors (IRFs) cause the creation of Interferons (In this case, IFN α and IFN β) (Arnold and Patton.) When a virus degrades an IRF, the cell is defenseless and unable to initiate immune response. Using Site Directed Mutagenesis three mutations were instated within the plasmid DNA. Mutations determine if the specificity between the strains can be interchangeable, or altered. OSU NSP1 (Porcine strain) degrades β -TrCP (β -transducin repeat-containing protein,) W161 (human) degrades IRF 3, IRF 5, IRF 7, and β -TrCP, (Zambrano et. al) and SA 11 cannot antagonize IRFs (Arnold and Patton, Qin et. al.) Although SA11 is unable to degrade IRFS, its behavior is similar to OSU NSP1 by modulating immune response and IFN production. The mutagenesis inserts three mutations by manipulating a specific region of amino acids. The first mutation would be changing OSU (porcine) to match W 161. In theory this should cause OSU to degrade IRFs and have less specificity The second mutation would convert W161 to be similar to OSU. Similar to the previous mutation, W161 may have more specificity. The third mutation involves SA11, a strain that does not usually degrade IRFs or β -TRCP (Samuel.) If the mutation occurs, the strain may have the ability to degrade either β -TrCP or the IRFs that W161 is capable of degrading.

Introduction:

Interferon regulatory factors are proteins that play an important role in the cellular immune response by detecting the presence of viral DNA or tumor cells. They initiate the creation of Interferons, which further mobilizes the general immune response (De Weerd et. al.) Once the cascade is activated, they can not only interfere with viral replication, but also signal other non-infected cells to defend themselves. This “defense” in the surrounding cells comes in the form of Protein Kinase R, (PKR) which is released by the Interferons and inhibits the protein creation of new viral units (Highleyman.) Protein Kinase R also has been suggested as a potential tumor suppressor (Mohamed et.al.) Interferons can also obstruct the virus from entering the cells (Highleyman.) There are only nine different IRFs in humans, but 11 IRFs total have been discovered varying by species (Huang et. al.) The IRFs of interest in this experiment are IRF-3, IRF-5, and IRF-7 because the human Rotavirus NSP1 degrades these interferons. (Zambrano et. al.)

The Interferons being discussed are Type I interferons because they are triggered by a viral interaction. Type one Interferons are considered only “IFN α and IFN β .” Interferons cause the initial immune response (i.e. swelling, generic antibodies.) The creation of Interferon β comes directly from infection, and then Interferon α follows soon after. (Arnold and Patton; Marie, Durbin, and Levy) The interferons effected by the rotavirus (IRF-3, IRF-5, and IRF-7) have been identified as acting as “direct transducers of virus-mediated signaling.”(Barnes et. al.) This means the first Interferon that is degraded by Rotavirus NSP1 is IFN-3, which usually activates IRF-7 in the immune response. Together IRF-3 and IRF-7 (IRF-7 regulates) create α and β IFNs, or type I IFNs. (Barro and Patton; Barnes et. al) With the degradation of IRF-7, the Rotavirus NSP1 is able to enter the cell. IRF-5 is also degraded because it is able to increase IFN

induction, and initiates “apoptosis during viral infection” (Barro and Patton.) These Interferons have been picked because they all use the same “Proteasome-dependant mechanism” that is specifically identified by the NSP1 Rotavirus (Barro and Patton.) The final target of the Rotavirus is β -TrCP(*β -transducin repeat-containing protein*), and after degradation, the NF-kB immune pathway is inhibited (Arnold and Patton.)

An important aspect of this experiment is the use of Strategene’s Quik Change II XL Site Directed Mutagenesis Kit. (Catalog # 200521) This kit is made specifically for the mutation of double stranded plasmids. Among other reagents in the kit, the XL Gold Ultracompetent cells have been made precisely for the take up of previously mutated DNA. The DNA polymerase PfuUltra™ high-fidelity (HF) DNA polymerase assists with the Extension step to assist the primer with annealing to the Template strand of DNA. The kit further includes Quik Solution that is specifically made for plasmid that are bigger in size (“*QuikChange XL Site-Directed Mutagenesis Kit.*”) the plasmid at hand, pEYFP-C1, altogether with the rest of the reagents is 6.9 kb. Therefore its size categorizes it as a bigger plasmid. Each reagent in the kit had a highly specialized purpose.

Methods:

The plasmid pEYFP-C1 was obtained from a glycerol stock, inoculated and purified using a Qiagen DNA purification kit (“*QIAprep Spin Miniprep Kit.*”) In this kit, the cells were lysed, neutralized, centrifuged and washed. The DNA was then extracted after a series of filtration steps (“*QIAprep Spin Miniprep Kit.*”) The plasmid DNA was made into 2.5 ng, 5 ng, 10ng and 25ng dilutions in order to find which would have the highest efficacy. Another respective trial had primer dilutions, which were intended to help with finding the most efficient combination. The primer dilutions were as follows; 0.125 μ m, 0.25 μ m, and 0.5 μ m. These

dilutions were matched with 25 ng of DNA. The desired mutation was added to the primers and amplified through a standard PCR. The parameters of this PCR can be found in the Appendix. A control PCR was run with a pWhitescript 4.5 kb control plasmid along with two oligonucleotide control primers. After the PCR reaction was spun down, a Dpn I restriction enzyme was added to eliminate the parental, non-mutated double stranded plasmid. After a one-hour incubation at 37° C, the reaction was ready for Transformation (“*QuikChange XL Site-Directed Mutagenesis Kit.*”)

The Stratagene XL Gold Ultracompetent Cells were taken out of storage and allowed to thaw on ice. The needed amount of 1.7 ml tubes were put on ice to keep the cells chilled. The cells were treated with the β -Mercaptoethanol mix provided. A control transformation was also prepared using house cells and the pUC 19 plasmid. The Dpn I digested DNA was added and allowed to incubate on ice for 30 minutes. After the cells were heat shocked in a 42° C water bath, the cells were placed in ice for another small incubation. Nutrient media was added and the cells were further incubated and rotated at 37° C. After an hour, the cells were plated on their respective media. For the pUC 18 control only LB Ampicillin plates were used. The pWhitescript control was plated on an Ampicillin plate with color screening reagents; X-GAL and IPTG. These color-screening reagents were added onto normal LB- AMP plates. Finally, the pEYFP-C1 plasmid was plated on LB Kanamycin plates. The plates were allowed to incubate for 16-18 hours and the colonies were noted (“*QuikChange XL Site-Directed Mutagenesis Kit.*”)

After a minimum of 18 hours the plates were checked, if colonies were present they were further processed. This processing began with inoculating the bacterial colonies by swiping them with a wooden sterile stick and placing the stick in 5 ml of LB+ Kanamycin. The inoculated samples were allowed to shake at 200 rpm at 37° C. After the incubation period, the samples

were spun down and processed once again with the Qiagen miniprep kit. After the DNA was extracted and purified, the DNA was sequenced. After the DNA sequence was obtained from the ABI 3130 Genetic Analyzer the sequence was compared to the original OSU sequence to see if the mutations were notable. (“*QIAprep Spin Miniprep Kit*” and “*QuikChange XL Site-Directed Mutagenesis Kit*”) If the sequences do not match up with the mutated primer sequence, the result was a wild-type virus.

Data and Results:

Table 1:

Reagent Amounts for PCR Analysis		
Reagents:	Control: pWhitescript	Sample reaction (mutated plasmid)
10x Rxn Buffer	5 μ l	5 μ l
DNA Plasmid (diluted)	2 μ l	1 μ l (at 25 ng)
Forward Primer	125ng	(at varying dilutions)
Reverse Primer	125ng	(at varying dilutions)
dNTPs	1 μ l	1 μ l
Quik Solution	3 μ l	3 μ l
Deionized H ₂ O (total 50 μ l)	36.5 μ l	(based upon dilution amounts)

Caption: This table outlines the PCR mix of reagents used for the successful growth of the mutated colonies. These reagent amounts are based upon the suggestions from the “*Strategene Quikchange II XL Site Directed Mutagenesis Kit*.”

Table 2:

Number of Colonies Grown per Primer Dilution	
Colony Dilution:	Approximate of Colonies
0.125 μ M (Plate One)	70 colonies
0.25 μ M (Plate One)	>200 colonies
0.50 μ M (Plate One)	>300 colonies

Caption: This table represents the effect the dilutions took on the colony growth, it can be noted that the smaller the dilution, the less the colonies. Photos of the colonies can be referenced in the Appendix.

Discussion:

Due to the nature of plasmid, trial and error was imminent in each part of the experiment. There were many factors and dilutions to take into account. With many failed attempts, a few reagents had to be adjusted before colonies could manage to grow. This plasmid can be very difficult to work with. The environment and reagents around it must be perfect for the plasmid to successfully take up the mutations. The only signal of this success was whether or not the colonies grew. This “indicator” is the Kanamycin resistance that had been inserted into the mutated DNA. If the colonies did not grow on the LB+ Kanamycin plates, the cells did not gain the resistance to Kanamycin coded in the mutated OSU NSP1 flagged DNA.

There are many aspects that must be correct for the successful transformation. If the template DNA content is too high, the primers will not bind properly, and the same happens if there is too much primer. The first factor that was analyzed was the dilution of DNA. With the initial Nanodrop spectrophotometer reading of the OSU plasmid at around 350 ng/ μ l, the DNA needed to be diluted. The first series attempted was 200 ng, 100ng, and 50 ng DNA dilutions. The primer is stored at a stock dilution of 50 μ m, so 5 μ m was the initial dilution of the primers used. All the samples had failed to grow. A smaller dilution of DNA was completed next at 5ng, 10ng, 25 ng, and 50 ng with the primer still diluted to 5 μ m. It was assumed that the smaller dilution would help the cell growth, but this trial was also was unsuccessful indicating that the primer dilution needed to be adjusted. For the next trial, the DNA dilution was constant at 25 ng, and the prime dilutions were 0.125 μ M, 0.25 μ M and 0.50 μ M. The dilution of the primers led to the prosperous growth of the colonies, so it can be concluded that the primer amount was too high for replication to occur.

With continued failure, every aspect had to be questioned. The next option was to dissect the methods. The XL Gold cells that came with the kit seemed to be a better fit for consistency. Another option was the Invitrogen DH5- α cells, which had been very good at taking up extremely difficult plasmids in the past. In the end, the XL Gold cells were able to grow the colonies, but everything else had to be adjusted first. Another questionable aspect was the use of the β -mercaptoethanol in the kit. The Strategene protocol states that 2 μ l of β -mercaptoethanol must be added to the cells. After it is added, they must incubate on ice for 10 minutes with swirling every 2 minutes (“*QuikChange XL Site-Directed Mutagenesis Kit*”) β -mercaptoethanol is a well-known reducing agent, and it also is used to reduce the protein’s disulfide bonds, and to collect free oxidizing radicals (“*Mercaptoethanol*”). The final factor that was questionable in nature was the nutrient media used in the transformation. The kit specifies to use NZY⁺ broth, but this broth is made of casein hydrolysate which is literally a hydrolyzed milk protein. (“*Casein Hydrolysate*”) With such small differences noted between the media nutrient broths, regular, house made SOC media was used in the transformation.

Notably, the much smaller dilution of the primer helped immensely but there were other factors at hand that could have further affected the competent growth. The effective attempt had a few alterations that may have helped the survival of the cells. The first was the use of pre-mixed LB Agar instead of hand measuring the LB ingredients and combining them with agar manually. After auto clave, the selective antibiotic Kanamycin was added and the plates were poured. The fresh plates were used for the transformation later that day. The main indicator that the fresh plates could have affected competence was due to the control plasmid. Before the new plates, the control plasmid would only yield around 6 blue colonies. After the plate change on the next round, there were too many colonies to count on the control plasmid plates. The final

change endured by the efficacious growth was the use of an entirely new bottle of SOC media. The media is used as a nutrient broth, and must be very clean for the cells to properly use it. The previous bottle that was used for all trials had been used for previous experiments and was potentially contaminated.

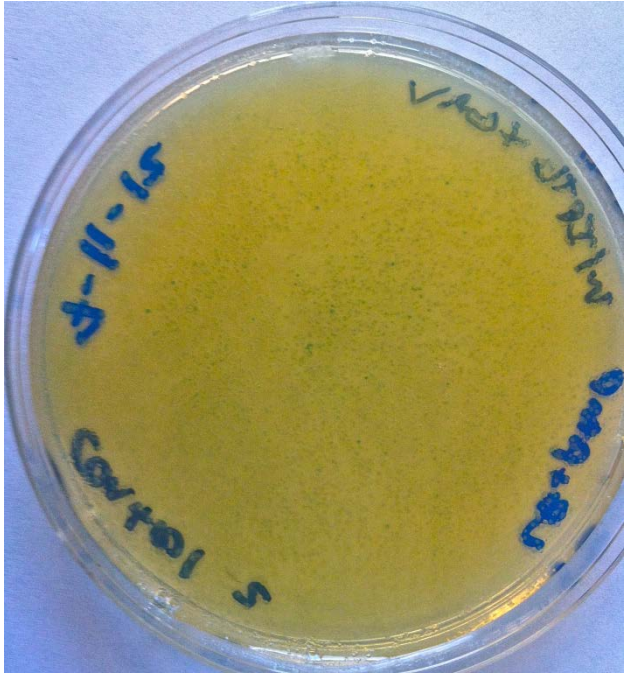
Overall, with all the adjustments throughout the process, the plasmid had to be analyzed to see if the mutations were properly integrated. Nine colonies were taken from the plates, three from each dilution. These colonies were further processed and eventually sequenced. After the sequence was obtained, an aligner tool was used to compare the extracted sample sequence and the sequence of the original OSU sequence. From the sequence it was determined that the mutated Primer did not properly line up with the DNA sequences from the sample. The mismatches were also not consistent throughout the samples. This meant that the sequence was from a Wild-type Strand of NSP1 and the samples were unsuccessfully mutated.

Conclusion:

It is definite that colonies grew after further development of the procedure, and the use of fresh reagents. With further analysis, it can be determined that the samples extracted from the colonies were of a wild type virus, and they did not contain the necessary mutations inserted into the initial Rotavirus OSU NSP1 sequence.

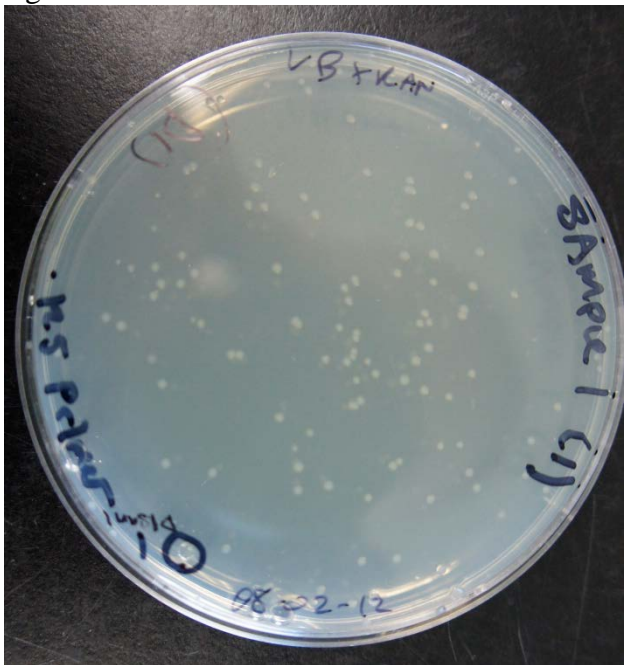
Appendix:

Figure 1:



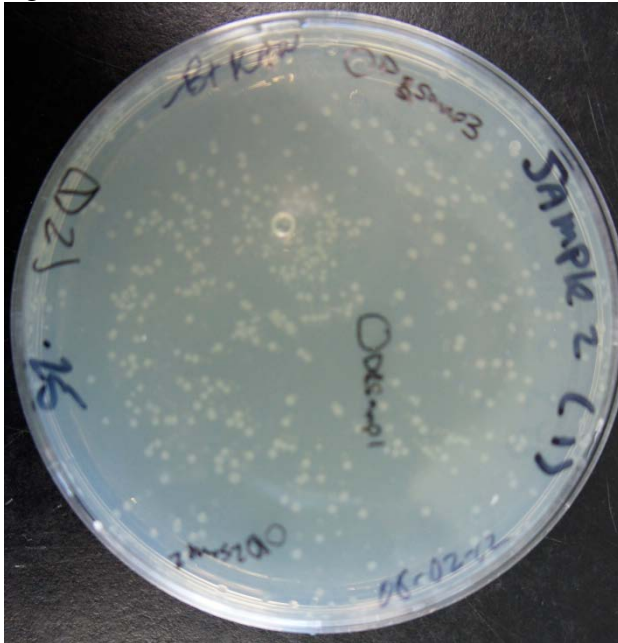
Caption: This photo represents the effects that the color selective XGAL and IPTG has on the control plasmid as represented by the blue colonies.

Figure 2:



Caption: This photo represents the colony growth of the 0.125 μM plate.

Figure 3:



Caption: This photo represents the colony growth of the 0.25 μ M plate. It can be noted that there are more colonies on this plate than the previous dilution.

Figure 4:



Caption: This photo represents the colony growth of the 0.5 μ M plate. It can be noted that this dilution contains the most colonies.

PCR parameters for OSU plasmid DNA:

Segment	Cycles	Temperature	Time
Denaturation	1	95 °C	1 minute
Annealing	18	95 °C	50 seconds
		60 °C	50 seconds
		68 °C	7 minutes (6.9 kb plasmid)
Elongation	1	68 °C	7 minutes

This table represents the suggested PCR parameters from the “*Stratagene Quikchange II XL Site Directed Mutagenesis Kit*.” It was not adjusted in any way from the specifications of the kit.

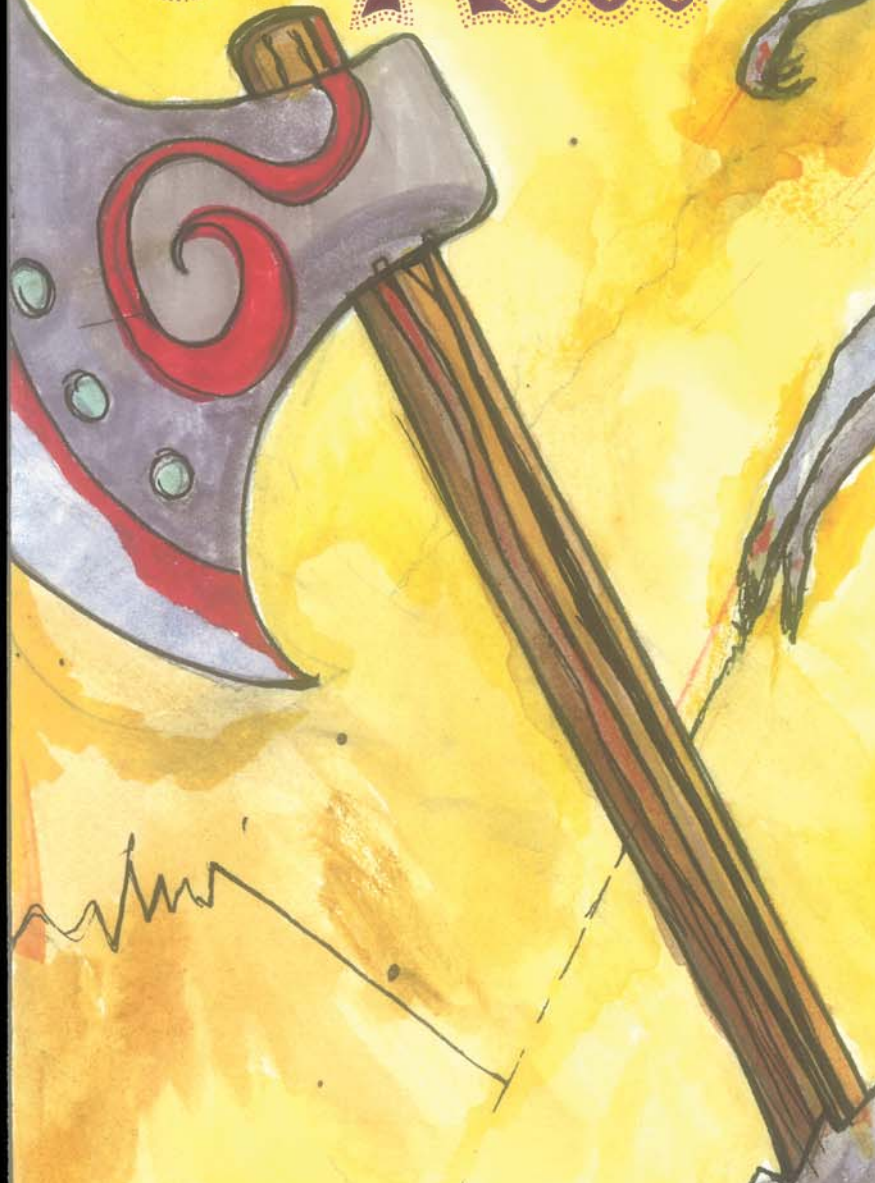
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DREAM of The Rood



J.L. Thornburg

The Dream of the Rood

An Early Old English Poem

Verse By
Jennifer L. Thornburg

Illustrated by
Jackson Thornburg

Illuminated letters and border
By Jennifer Thornburg

Copyright 2011 by Jennifer Thornburg

“That posteritie may know we have
not loosely through silence permitted
things to passe away as in a dreame.”

The Venerable Bede

Foreward

The Dream of the Rood is one of the oldest and most beautiful works of Old English literature. The word Rood is an Old Norse, or Viking, word for cross. The poem was inscribed in runic letters on the Ruthwell Cross, a preaching monument found in the kingdom of Northumbria (now Scotland). The eighteen-foot stone cross bears carved figures, biblical scenes, vine tracery, and lines of the poem. Though its authorship is unknown, scholars believe the Anglo Saxon Christian poets, Caedmon and Cynewulf, are possible authors. Both cross and poem are thought to have been created during the Golden Age of Northumbria, between the mid-seventh to the mid-eighth centuries.

The cryptic runes were a mystery until J.M. Kemble translated them into Old English in 1840. He noticed that they were the same verses found in the 10th century Vercelli Manuscript, where the poem appeared in its entirety. Originally, it was probably part of an oral tradition, sung or recited, and passed from generation to generation.

The Dream of the Rood is a poem written in the genre of dream poetry. There are three parts: a dreamer falls asleep and dreams that he sees a cross, then the cross is given the powers of speech, telling of its use as the instrument of Christ's crucifixion, and finally the dreamer reflects on what he has seen and heard. The depth and subtlety of the cross and dreamer's speech makes this an extraordinary literary piece.

An important theme in the poem is the portrayal of the crucifixion as a battle. Christ is depicted as a fearless warrior, very different from our modern conception of him. The poem's heroic language is evidence of the Viking influence. Used as an evangelization tool, it was important to represent Christ as a strong, brave warrior that men could identify with and relate to. The poem contains kennings; compound expressions from the Old Norse. "Speech-bearers" is a kenning that refers to men, or people. "Victory-beam" is the cross, "earth-house" is a tomb, and "High-father" refers to God. I retained some of the kennings in my rhymed translation to preserve the Old Norse influence.

I first discovered this beautiful poem in a college course taught by Professor Jerome Coffey, Ph.D., a linguist who is passionate about the history of the English language. He served as mentor for this project. At his suggestion, I translated the 156-line poem from Old English to modern English. My vision was to transform the Germanic alliterative style, in which most heroic poems are written, into rhymed meter. I wanted to create a form that parents could read to their children, so that this beautiful and important part of history would be shared again among the people. I studied the art of illumination, creating decorated letters to adorn the left hand pages. Celtic knotwork, and the inhabited vines on the Ruthwell Cross inspired the tree-branch border. My son, Jackson Thornburg, a Fine Arts graduate, created the artwork on the right hand page spreads.

Many, many thanks to Professor Jerome Coffey, the McNair Scholars Program, the Undergraduate Scholars Program, Career Transitions and my family.

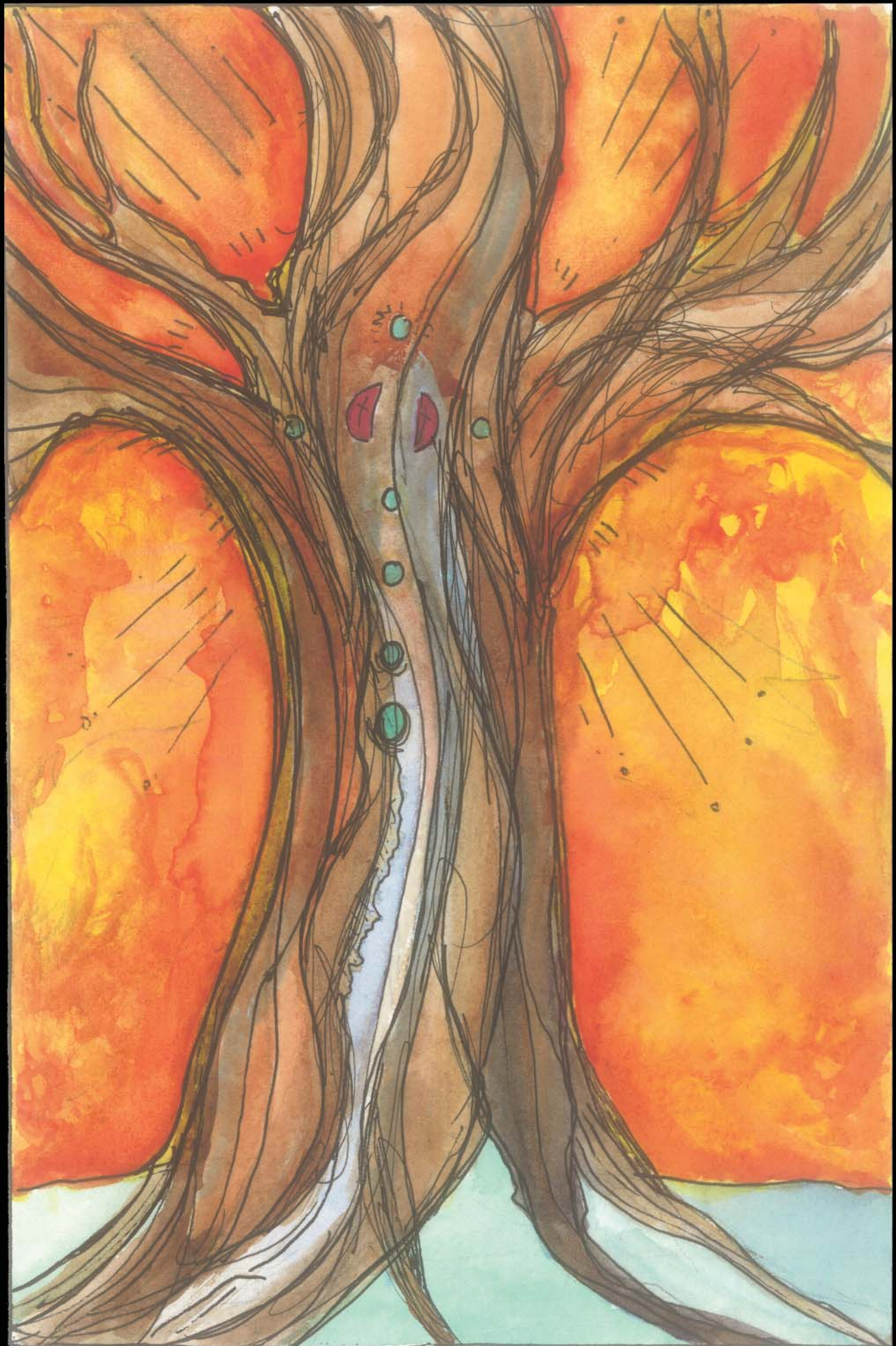
J.L.Thornburg

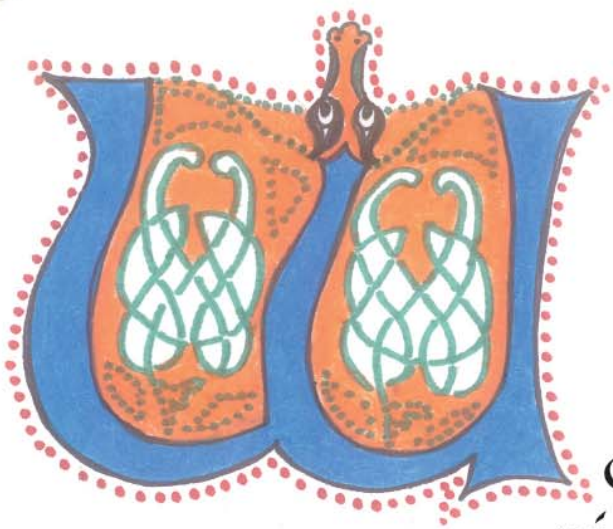
A decorative border made of a tree branch with several vines wrapped around it. On the right side, there are three colorful birds: a green parrot at the top, a red parrot in the middle, and a blue parrot at the bottom. There are also some red berries on the vines.

B

I.

Behold I dreamt a dream,
of which I wish to tell,
It came to me at middle night
when speech-bearers slept well.
It seemed to me I saw
a great and wondrous tree,
lifted up on high
in golden light shone he.
Earth's gems stood at the corners
five upon the span,
An angel host beheld there
bright beauty before man.
This was no wicked gallows.
The Holy Spirit beheld
men over the earth
where glorious creation dwelled.





ondrous was the
victory tree
and I so stained with sin,
yet glory's tree was shining,
gold and gems within.
But through the gold I saw
old agony and pain,
When blood flowed from the right side
I feared that scarlet stain.
I was all wracked with sorrow,
afraid at that fair sight,
the shining beacon drew me
wound round with jeweled light.
That beacon changed its colors
water flowed, then flood,
Treasures adorned the surface
drenched in streams of blood.



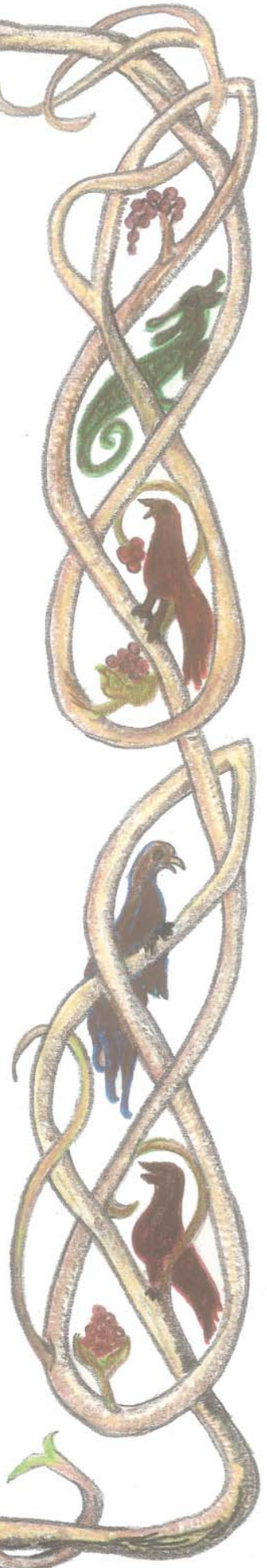




say there a long while
gazing on the Savior's cross
my sorrow welling forth
at witnessing this loss.
Then that tree began
to speak, to utter sound
the best of woods did talk
my heart it did astound.

II.

I listened in great wonder
as the tree then cried aloud
"Long ago I remember
they cut me down, so proud.
They moved me from my root
strong foes took me away,
they made of me a spectacle
on that grievous day.







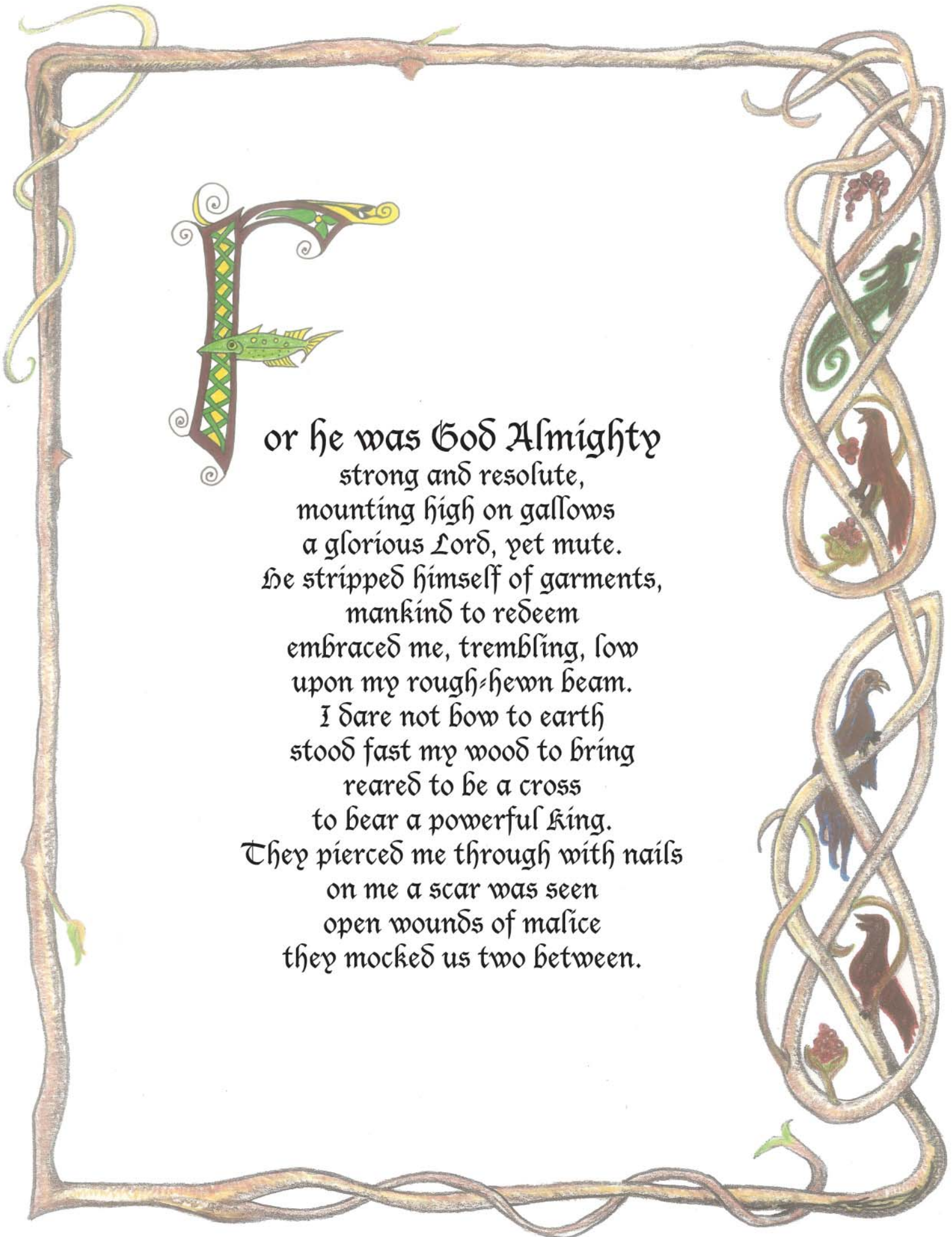
ursed ones, they carried me
upon their shoulders high
they set me on a hill
beneath the blackened sky.
Then I saw mankind's King
with great courage come
he climbed on me with might
with strength he did succumb.
I dare not bow nor bend
against the word of God,
though earth did shake and tremble
I did no more than nod.
These fiends I could still strike
destroy them with a blow,
but I stood fast and held
the warrior in his woe.







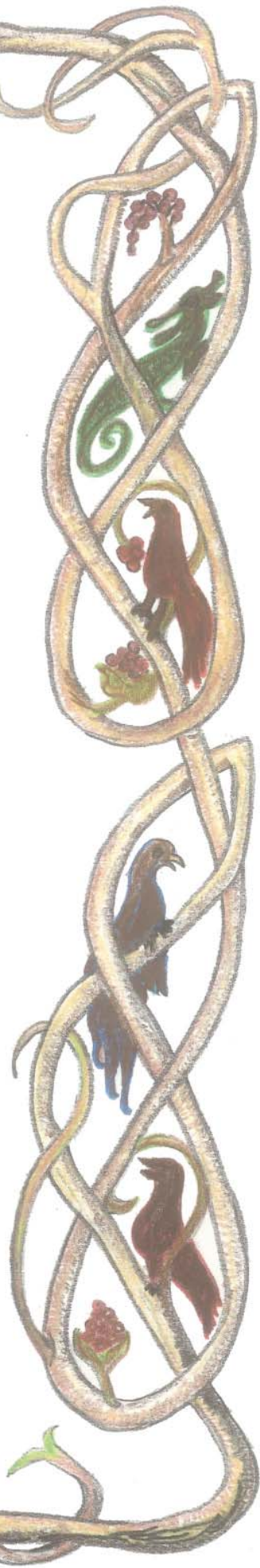
or he was God Almighty
strong and resolute,
mounting high on gallows
a glorious Lord, yet mute.
He stripped himself of garments,
mankind to redeem
embraced me, trembling, low
upon my rough-hewn beam.
I dare not bow to earth
stood fast my wood to bring
reared to be a cross
to bear a powerful King.
They pierced me through with nails
on me a scar was seen
open wounds of malice
they mocked us two between.

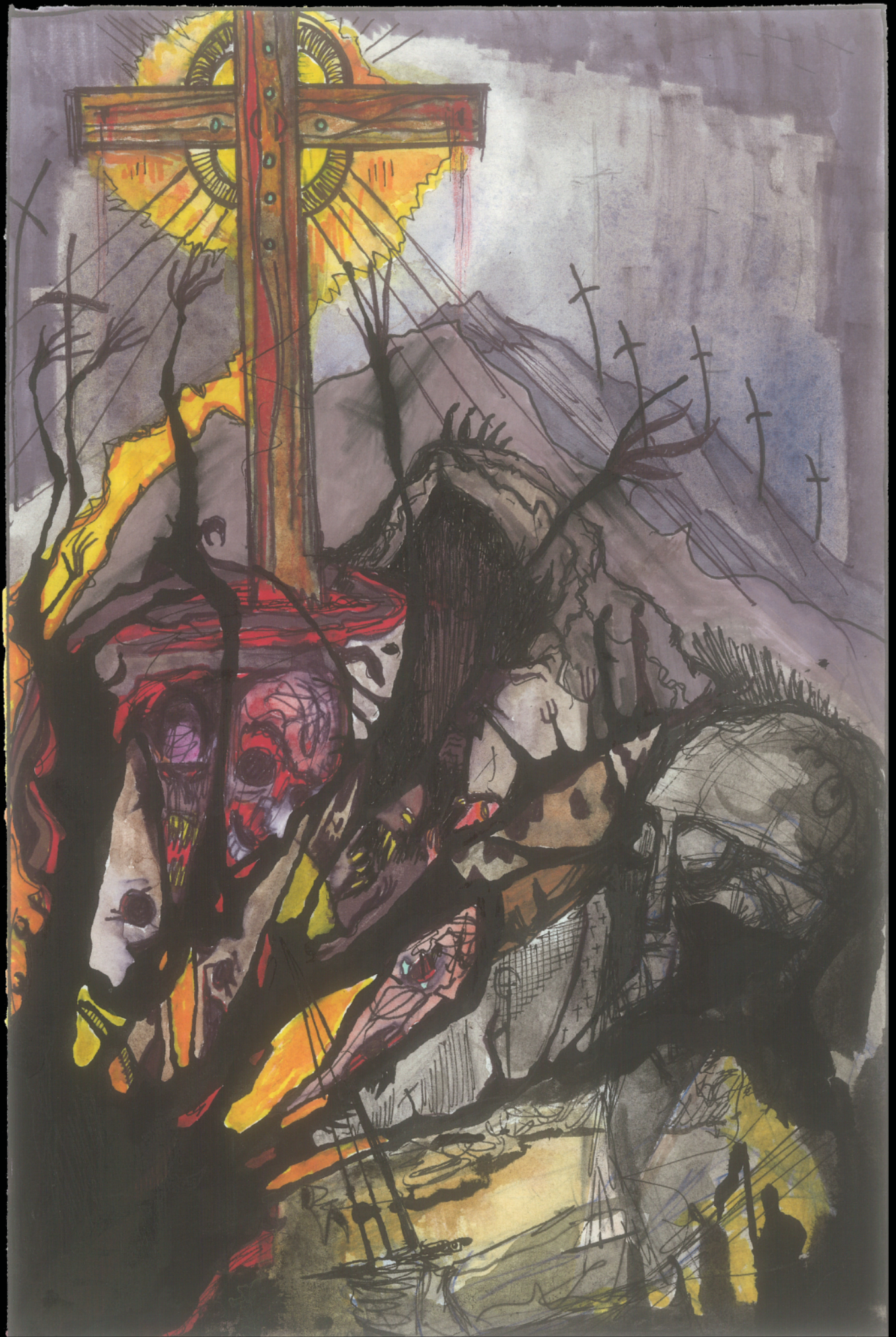






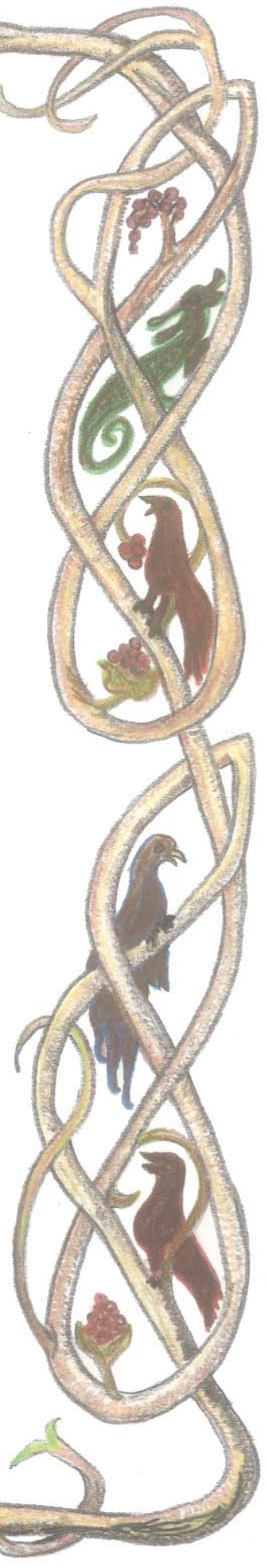
ashed in that man's blood
it poured out from his side,
his spirit he sent forth
he breathed his last and died.
Upon that hill fierce fate
struck cruelly Heaven's Lord,
when darkness wound about him,
and severed life's bright cord.
All creation wept
as shadow followed light
lamenting the king's fall
sorrowing at the sight.
Christ was on the cross,
from far and wide they came,
I saw them mourn the Prince
I bowed and cried his name.



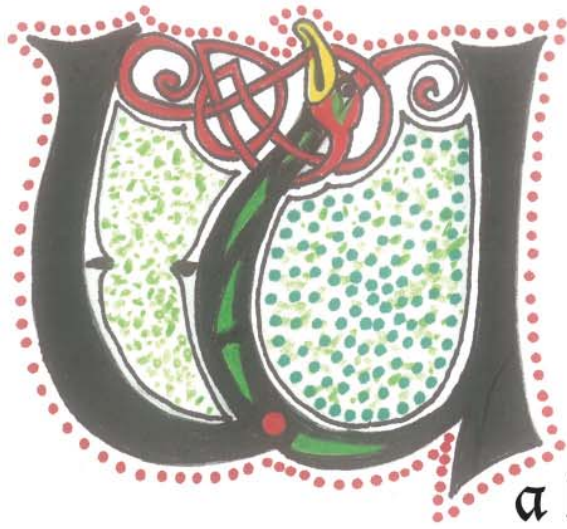




ore with piercing sorrow,
humbled by men's hands,
they raised him from that torment
released him from those bands.
Abandoned me, those enemies
and shot with arrows through,
wretched in the eventide
alone I grieved anew.
They lay him down, limb-weary
beheld they Heaven's Lord
built him a tomb, an earth-house
Death's sleep his dark reward.
In slayer's sight they carved
a tomb of brightest stone,
sang they a sorrow song
for Victory's Lord alone.







e wept
a long while in place
on firm foundation stood,
corpse cooled, our cries went up
fair life for mankind's good.
Then they cut me down
felled me to the earth,
buried deep and dark
in place of lowest berth.
However my Lord's friends found
me there and lifted me
with gold and silver dressed,
adorned this simple tree.

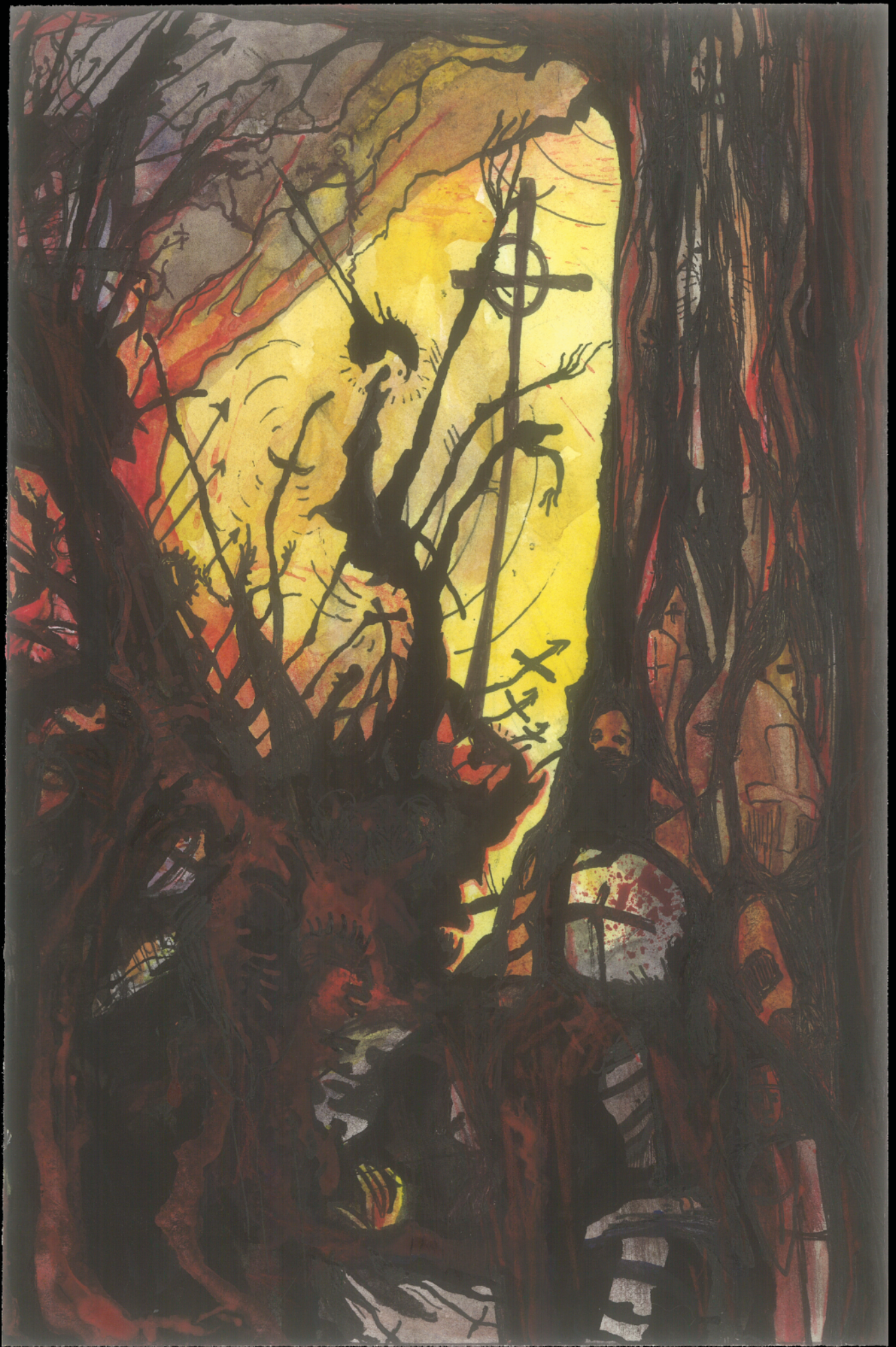






Now hearing, beloved warrior
of this wicked work endured
the fitting time has come
to speak the noble word.
Far and wide when men shall pray
to me on whom God hung
I'll heal all those who earnestly
his praises they have sung.
On me God's son did suffer
his glory makes me tower
tormented by my enemies,
that suffering brought great power.
I opened up the life-path
for voice-bearers to seek
their soul's home in the kingdom
if Ruler's name they speak.







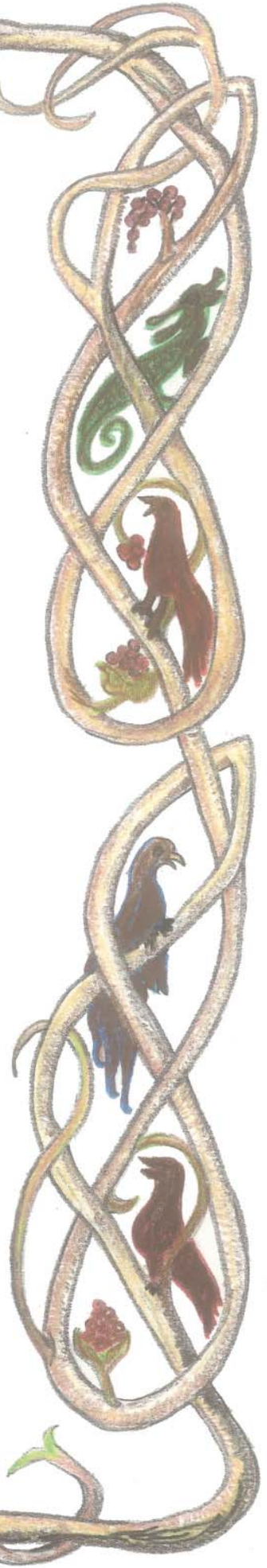
B

ehold then Glory's Prince
has lifted me on high,
above all forest trees
to guard this heavenly sky.
Even as his mother
Mary o'er all women kind
Almighty God has honored
and shall not leave behind.
Now, I then command
beloved man of mine
seeing this, you tell
how one tree held the Divine.
He suffered much for mankind's sins
and Adam's seeds of old,
the Prince marched toward his fate
his steps were sure and bold.
God tasted death but rose again
with might to help all men,
He comes again upon the earth,
to heaven he'll ascend.





On Judgment Day
the Lord himself
with angels and with power
will deem who found in fleeting life
the right to stand, not cower.
Wilt fearless be, and unafraid
if asked where is the man
who tasted death upon the beam
when that dark day began?
Many then will be afraid
and little think will they
what he might profess
what he, to Christ will say.
There is no need for anyone
to fear if they shall bear
within their breast, the cross
that noble beacon fair.
For through the Rood shall every
soul the kingdom keep
from Earth's Way the Wielder seeks
the souls that he would reap."





The page is framed by a thick, textured tree branch that runs horizontally across the top and bottom. From the top branch, several thin, light-brown vines spiral down and across the page. On the right side, these vines are more densely packed and feature several small, dark brown birds perched on them. Some vines also have clusters of small, dark red berries. The overall style is reminiscent of traditional Celtic or medieval manuscript illumination.

III.

Lprayed then to that cross
with zeal and joyful heart
Though much alone, inspired
this journey to take part.
Such longing burned within my soul
of hope and life and light
may I, much more, than other men
hold Rood within my sight.

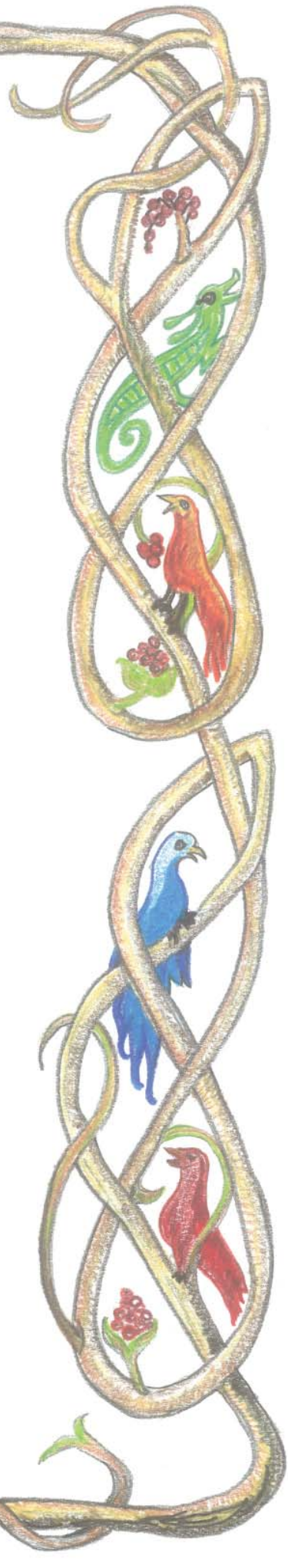
Prayer is my protection
though many friends have left
departed from the joys of earth
yet I am not bereft.
for they have searched for Glory's King
and him indeed they've found
high father welcomes them with joy,
who prayed upon earth's ground.

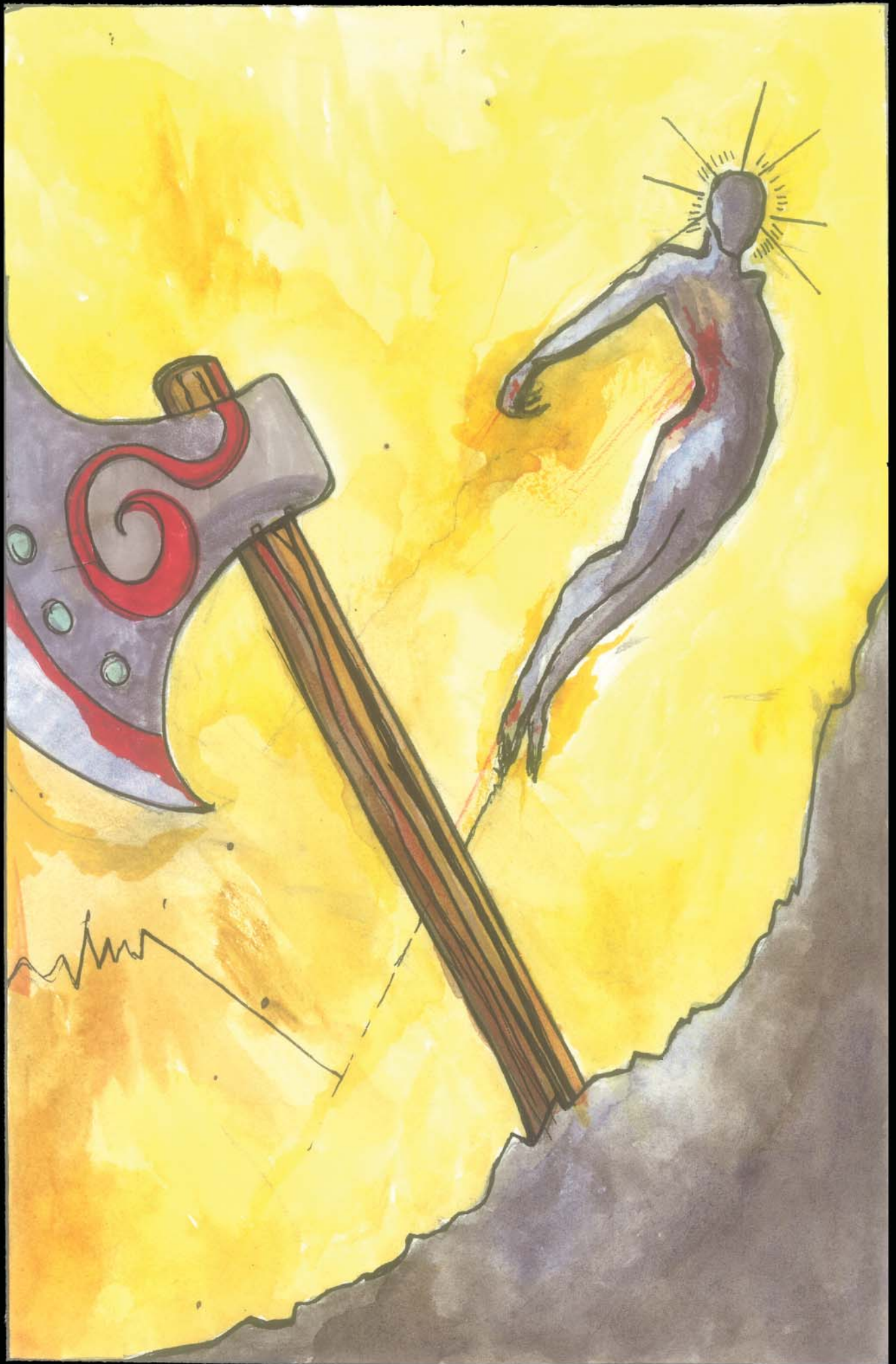




With the one
High Father

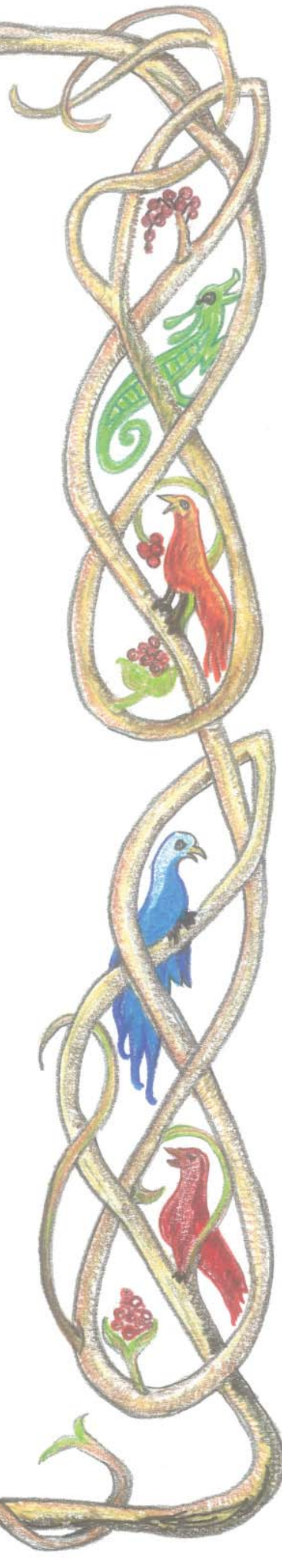
I, too, hope to dwell
He'll fetch me from this fleeting life
of bliss and joy I'll tell.
I'll dine with the Lord's own people
and sit at banquet feast
Have everlasting joy
and everlasting peace.
The Holy Ones have Glory
unending joy possess,
the Lord will be my friend
who suffered, none the less.
Formerly he agonized
on that gallows tree
from mankind's sins he loosed us
his fierce fate set us free.
Gave us a heavenly dwelling
our hope he did renew,
endured the burning fire
that we might live anew.







he Son was
victory^{sure}
on that journey to the tree,
mighty and successful
the angel host and he.
They marched into God's kingdom
in Glory the Wiesder came
the Homeland he had reached
Almighty God his name.





MEASURING RESTING METABOLIC RATES IN CATTLE OF VARYING BODY WEIGHTS

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ABSTRACT

The objective of this preliminary study was to develop a repeatable indirect calorimetry procedure for measuring real-time resting metabolic rate (MR) in cattle of varying body weight (BW). It was hypothesized that BW would be linearly associated with MR. Animals used in this study were two sets of Holstein bull calves and one set Angus x Hereford heifers that were categorized into three weight groups. The three weight groups were defined as: heavy, middle, and light weighing 322, 167, and 72 kgs, respectively. Resting MR was measured in a retrofitted airtight horse trailer using the Field Metabolic System from Sable Systems International based in Las Vegas, NV. The horse trailer had a volume of 8.3 m³. A PCV pipe connected to Expedata's computerized pull mode respirometer sampled air within the chamber. The respirometer was programmed to measure O₂ consumption (V_{O_2} - L/min), and CO₂ production (V_{CO_2} - L/min) with a flow rate of 1,000 L/min. Individual animals were confined to the trailer for a 30 minute period or however long it took for V_{O_2} to stabilize. The V_{O_2} inhaled, V_{CO_2} evolved and BW of each animal was measured in both runs. Run One was conducted on 28-Feb-2013 and Run Two was conducted on 7-Mar-2013. The respiratory quotient for each animal was calculated by dividing V_{CO_2} by V_{O_2} for each run.

The RQ for Runs 1 and 2 was averaged and calculated to be 0.75 L/min. The respiratory quotient reflects the animal's diet at a resting metabolic rate and is expected to range from 0.70-1.00 L/min. A value of 0.70 L/min represents lipid catabolism and a value of 1.00 L/min represents carbohydrate catabolism. The correlation of V_{O_2} , V_{CO_2} , and BW measurements between the two runs was 0.89, 0.91, and 0.999. The relationship between an animal's BW and MR was explained by the equation: $V_{O_2} = 0.0173 \times BW^{0.8037}$ where P was less than 0.01. This P value indicates that the portable metabolic chamber measured resting metabolic rates of cattle in a consistent and reliable manner.

Key words: resting and basal metabolic rates, cattle, portable metabolic chamber, indirect calorimetry

Introduction

Respirometry is a versatile and powerful tool for scientific discovery in animal biology (Lighton, 2008). Metabolic rate (MR) can be measured using indirect calorimetry through a procedure that measures rate of inhaled O₂ and respired CO₂. The metabolic rate of an animal is affected by many body mass,

external and internal temperatures, activity level, and production cycle. The earliest use of calorimetric procedures was used to determine maintenance energy requirements for growing and finishing cattle (ARC, 1965; NRC, 2000). Indirect calorimetry historically required confinement chambers that were immobile and laboratory-controlled (Kelly et al., 1993). This limited the number of cattle that could be measured feasibly and restricted the number of extrinsic factors that could be assessed in an economically manner (Kelly et al., 1993; NRC, 2000). There are a number of companies who manufacture calorimetric equipment for conducting research in the field. Measuring resting metabolic rate in a field setting is more accurate since the animal doesn't have to adapt to a new environment, diet, or temperature conditions.

A horse trailer was modified into an enclosed airtight chamber was used to contain the cattle. An open-flow respirometer from Sable Systems was utilized to determine the volume of O₂ consumed and CO₂ produced by individual animals. The objective was to develop a method that was repeatable and applicable in on a farm setting. Measuring and calculating the correlation of V_{O_2} , V_{CO_2} , and BW between numerous metabolic measurements on individual animals validated the method. The secondary objective was to assess the scaling of metabolic rate for cattle of varying body weights. A null hypothesis was made that repeated metabolic measurements were not correlated and that metabolic rate of cattle did not vary by individual BW.

Materials and Methods

Trailer

An enclosed two-horse horse trailer was converted into the portable metabolic chamber used for this study. All doors and windows were sealed with ACE brand 50mm weather-stripping. All of the welds were sealed with 100% Ace brand silicone. Two smoke bombs were detonated to ensure that the trailer was airtight. After each smoke bomb detonation, air leaks were fixed by adding more weather-stripping and silicone. PVC pipe, 3.8cm in diameter, was installed throughout the ceiling of the trailer. Excurrent air samples were collected through nine 1cm openings in the PVC pipe. Incurrent air was allowed to enter through a 3cm damper placed installed into the bottom right door of the trailer.

Animals

The resting metabolic rate of two sets of six Holstein bull calves and three Angus x Hereford heifers was

Measuring Resting Metabolic Rates in Cattle of Varying Body Weights

measured. Cattle were randomly selected from three groups of research animals at the Bozeman Agricultural Research and Teaching Farm in Bozeman, MT. Body weights of these animals represented three categories. The three heavy cattle had average BW of 322kg with a variation of plus or minus 31 kg. The three medium cattle had an average BW of 167 with a span 9 kg in either direction. The light cattle had an average BW of 72 kg and had only a 4 kg variation. Different diets were fed to all three groups of cattle. The heavy cattle were consuming a forage-based diet consisting primarily of alfalfa hay. The medium cattle were consuming a concentrate-based diet, which consisted of barley, alfalfa-hay, and supplement. Barley made up 88% of the diet, alfalfa-hay made up 10% of the diet, and the supplement made up the other 2%. The light cattle were fed milk replacer plus an ad libitum concentrate diet of dairy calf starter.

Indirect Calorimetry Procedure

The volume of the metabolic chamber had 8.3 cubic meters of airspace. The first run of individual metabolic rates was measured on 28-Feb-2013. Run 2 was repeated on the same animals on 7-Mar-2013. A Field Metabolic System from Sable Systems, Las Vegas, NV was hooked up to the portable metabolic chamber.

During Run 1, the trailer was pulled into a 12°C heated shop. The drive through door was left partially open for the exchange of air. During Run 2, the trailer was parked outside. The temperature was 1°C and varied only 2 degrees throughout the day. On both days the metabolic rates were sampled between 900 h and 1800 h. All animals were feed at 700 h. All animals were weighed without fasting before they were loaded into the trailer. The Field Metabolic System sampled air continuously, alternating between ambient air from outside the chamber and air pulled from the chamber on 5 second intervals. The ambient air served as a baseline. Temperature variation in ambient air was standardized by the respirometer by heating the air to 25°C prior to measuring and collecting any data. The flow rate was set at 1000 L/min and held constant throughout the experiment (Sable Systems International, 2010).



Figure 1: This horse trailer adapted as an indirect calorimetry system for measuring rate of oxygen consumed and carbon dioxide produced by cattle.



Figure 2: A field metabolic system from Sable Systems, Las Vegas, NV, USA) hooked up to a horse trailer and used for measuring rate of oxygen consumed and carbon dioxide produced for cattle confined to a horse trailer.

One mL subsamples of respired air were passed through the column where the flow rate, water vapor, CO₂, and O₂ were measured. Readings were monitored every second by the gas-analyzer and recorded in the Expedata program. The data program outputted rates of CO₂, and O₂ in L/min, which were used to calculate the respiratory quotient ($RQ = V_{CO_2}/V_{O_2}$). Respiratory quotients were calculated for each animal per run. Metabolic rate in L/min was represented by the rate of O₂ consumed (Lighton, 2008).

A computerized Expedata open-flow respirometer documented O₂ consumed CO₂ evolved. The O₂ units were listed as of L/min (V_{O_2}). The CO₂ produced was recorded in units of L/min (V_{CO_2}). The respirometer measured both of these parameters

Measuring Resting Metabolic Rates in Cattle of Varying Body Weights

simultaneously. Cattle were confined to the trailer on an individual basis during the data collection period. Metabolic rates were measured over a period of 30 minutes or until V_{O_2} and V_{CO_2} readings had stabilized. Some animals took up to 45 minutes prior to settling down.

Statistical Analysis

Pearson's correlation coefficient was used to determine if BW, RQ, V_{O_2} , and V_{CO_2} measurements were correlated between Run 1 and Run 2. A t-test was used to determine if RQ of individual animals differed between Run 1 and Run 2. Linear regression was used to determine if MR was related to BW. Differences were considered significant at $P \leq 0.05$.

Results

Correlations of Run 1 and Run 2 for BW, RQ, V_{O_2} , and V_{CO_2} measurements were 0.999, 0.72, 0.89, and 0.91. Average RQ for Runs 1 and 2 were 0.75 L/min and 0.74 L/min, respectively. The relationship between an animal's BW and MR was explained by the equation: $V_{O_2} = 0.0173 \times BW^{0.8037}$ where $P < 0.01$ as seen in Figure 3. Table 1 shows value of individual plots on the graph.

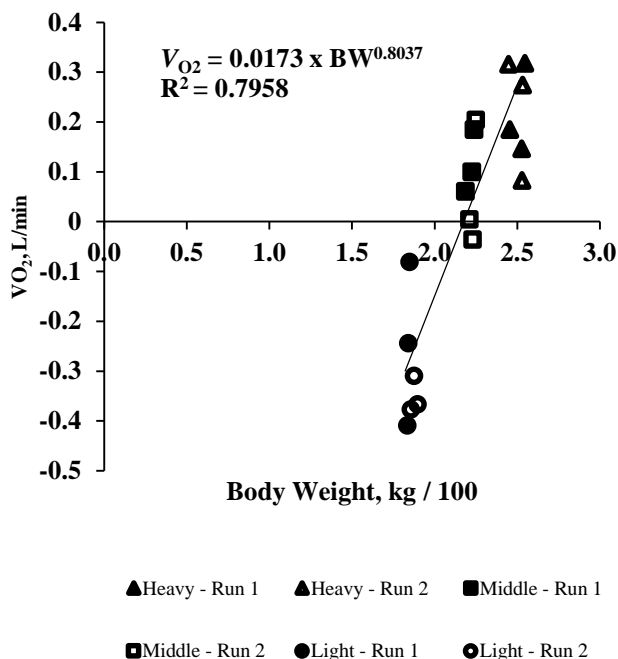


Figure 3: Oxygen consumption (V_{O_2}) for individual animals as a function of body mass using a logarithmic scale.

Discussion

This excitement was successful at developing a metabolic chamber for measuring metabolic rates in cattle. Results were found to be highly correlated when comparing the metabolic rates measurement of cattle between Run 1 and Run 2 as BW, RQ, V_{O_2} , and V_{CO_2} correlations were 0.999, 0.72, 0.89, and 0.91, respectively. It is also important to remember that the identical animals were used in Run 1 and Run 2.

Respiratory quotients for animals at resting metabolism commonly range from 0.70-1.00 L/min (Lighton, 2008). Respiratory quotients for heavy, middle, and light cattle in this study were within the following ranges: 0.71, 0.78, and 0.75, respectively. This further supports the reliability of the results.

The settings and principles of the chamber and respirometer design were chosen to standardize all data points. Air samples were scrubbed from foreign particles using selectively permeable membranes to minimize error in the data points. Corrections were made for varying barometric pressure and humidity in the air. Since the trailer chamber was not sealed 100%, continuous flow respirometry was chosen. Pull mode respirometry was chosen over push mode to gain consistency in the measurements. A baseline was established for every animal to measure the incurrent gas concentrations flowing through the chamber. The flow rate of 1000 liters per minute was chosen on desires of temporal resolution, which is the time required for respirometer gas plateaus to be reached. Animal excretions were removed from trailer after every animal to insure measured gases were emitted from the animal and not from the excrement.

The scaling of metabolic rate over cattle of varying body weights was also accessed. The relationship between metabolic rate and body mass is known as the Kleiber relationship. This relationship is important for understanding how much of the difference in metabolic rate is attributed to body weight (Kleiber, 1958; Kleiber, 1961). In this study, the mass scaling coefficient was 0.80. A mass scaling coefficient of 0.80 means that for each additional kg in the animal's BW, the rate of oxygen consumption increased 0.80 L/min. This value compares to the literature value for metabolic size, which is $BW^{0.75}$ according to the Kleiber equation.

The cattle were allow to rest for 30 minutes in the portable chamber prior to collecting data to minimize the effects of handling stress. This timeframe was determined from amount of time it took for the V_{O_2}

Measuring Resting Metabolic Rates in Cattle of Varying Body Weights

and VC_{CO_2} measurements to stabilize. A calm animal was defined as an animal that either: laid down, or had minimal variability in CO_2 and O_2 trend lines, and / or demonstrated low O_2 consumption and CO_2 production rates. Given that RQ rates on individual animals were measured on separate days it was concluded that 30 min was adequate for this pilot project.

There was an 11°C difference in ambient temperature on experiment days. Extreme temperatures affect MR of cattle (Young, 1975; NRC, 2000). Temperatures above the critical temperature cause cattle to increase MR so that they may dissipate body heat. Temperatures below the critical temperature cause cattle increase to MR to produce body heat (NRC, 2000). In both these instances, cattle had time to acclimate to these temperatures. Daily high and low temperatures for two days prior to collecting data varied by only 3°. The temperatures were likely not above or below their upper or lower critical temperatures that affect basal metabolic rates. Thus, it is presumed that temperature didn't affected MR of these cattle, because the rate of oxygen consumed was highly correlated between Runs 1 and 2.

The objective of this study was to determine the portable metabolic chamber yielded reliable and repeatable measurements. Therefore, the effects of gender, age, diet, and temperature variation between runs and animals were neglected. In the future, studies should consider the factors that affect metabolic rates.

Acknowledgements

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