BORLAUG-RUAN INTERNSHIP

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ACKNOWLEDGEMENTS

Throughout my experiences with the World Food Prize program, I have always been moved by the immense amount of kindness and compassion that all the involved people demonstrate. Passion is no doubt the key ingredient to such meaningful organizations, and this passion is reflected through the number of people working every day to change our world for the better.

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country of Peru. Above all, thanks for teaching me not only about scientific research but also about Peruvian culture and the intricacies of human understanding.

Last, but certainly not least, I would like to thank my encouraging family for allowing me to embark on this amazing journey.

I. INTRODUCTION

As a little girl I was always getting lost, straying from my parents in shopping malls and grocery stores, drawn to the distant and unknown. As I grew older, I kept my love for exploration and discovered another love as well – an interest in the not only *what* things were, but also *why* they were. I discovered that science textbooks seemed to be much more leisurely reads than the pages of other subjects. Projects, museums, and the "magic school bus" kept me far too amused to prove me normal. Experimenting with various household products became a curiously exciting pastime.

Before embarking on my two-month internship in Lima, Peru, I was convinced that I had no concrete talents; I was no piano prodigy, nor was I an exceptional dancer. Yet, through many experiences I have come to understand that these two passions – the thirst for adventure and the hunger for knowledge – have shaped me as a person, have become compasses for the roads that I take. And, perhaps talent is not limited to exceptional personal ability. Perhaps talent, like everything else in this grand world, is what we make it.

I discovered my passion for the issue of food security in my sophomore year of high school. After participating in a three-week school construction project in Tororo, Uganda, I was hooked. Suddenly, a path that I had never imagined before bloomed before my eyes. I had heard about the World Food Prize program through a number of friends and classmates, and there was no doubt in my mind that it was something I wanted to do. With a new goal in mind, I set to work preparing for my paper and applying for a seat at the World Food Prize Youth Institute.

II. 2006 WORLD FOOD PRIZE SYMPOSIUM

Upon my arrival at the Youth Institute, I was introduced to room after room filled with influential people. Although I was at first intimidated by these scientists and leaders, I soon found that they were not only minds to be admired but also to learn from, people through which I could learn more about the world around me and the issues surrounding food security today. I realized that they were people who I could not only talk to but also *communicate* with, friendly and easygoing mentors who loved to share with me their opinions and ideas and who happily answered my burning questions. Throughout the symposium I eagerly consumed each word from intellectual speakers, scribbling down notes and striving to understand each topic.

Just as influential as my connections with the adults were my interactions with the peers and fellow students. I was thrilled to see so many bright, dynamic teens, all interested in the issue that continues to grow and striving to make a difference in the world. Through our exchanges of ideas and brainstorms at the Hunger Banquet, we learned to appreciate, listen, and value one another. I was impressed by the number of insightful points that I heard throughout the weekend, and came to respect and admire each person whom I met.

When the 2006 interns began their presentations, I was fascinated by the depth of their experiences and the research studies they had conducted. Like them, I longed to spend my summer doing what I love, combining science and human studies, learning not only about research but also about independence, about another country, about humankind, and about myself.

III. CREATING THE BRIDGE

In the weeks following the Youth Institute, I prepared my application papers and sent them out with anticipation. When I finally heard back, I tore open the envelope and found, to my great excitement, that I had been chosen as one of the 2007 Borlaug-Ruan summer interns. Although many other preparations had yet to be made, I felt mentally ready to embark on the journey of a lifetime. I was ecstatic.

The end of junior year flew by more quickly than I had ever imagined, and before I knew it I was headed, for the first time in my life, to Lima, Peru. As I sat in the airport, I thought to myself of the hectic weeks before; finals and AP tests at school, communications with past interns about the situation in Peru, and goodbye's. Perhaps pictures and past papers seem like enough of a background, but indeed I felt completely confident yet horribly unprepared. On most excursions, I try to have an image in mind of where I'm going and how it will be. But, with when I boarded the plane on June 8th of 2007, I had no idea what changes I was about to face – in my life, in my surroundings, and in myself.

Figure 1: My host family Edwin Bartolini, Ida Bartolini, and Ida Bartolini Senior

I climbed off that same plane that midnight, dazed and crushed under a too-heavy backpack. A man was waiting for me as I walked out with my luggage, and the strangeness of the moment struck me. Helpless, I was left to only trust. As I stared out the window of the burgundy Lincoln, I drew in the city around me, my eyes feasting hungrily on the nighttime scene of Lima. Bright neon lights flashed from a series of midnight hubs; police sirens cried their wailing calls.

After what seemed like a lifetime of lurching and speeding through winding streets, we finally arrived. I was greeted warmly at the door by Ida Bartolini, my host mother, and shown my own room. I fell asleep to the sound of honking and screeching in the streets, pleased that I had survived the first few hours of my two-month stay in Lima, Peru.

I awoke the next morning to the cock-o-doodle-doo of a rooster, the family pet I was soon to meet. I ate breakfast with the Bartolini's, their kind words calming my nerves and spirits. Ida my host mother, Edwin my host father, and Milena, their daughter, treated me with the same kindness that I felt that day throughout the entire trip. I was touched by their sincerity, their thoughtfulness, and their patience with me and my shaky Spanish (Fig.1).

The first weekend passed with a blur; I struggled to match a plethora of names with faces, made all the harder by Spanish explanations that took me unreasonable amounts of time to understand. Although I was incredibly tired, I was even more excited, and could not wait to explore the new world in which I had arrived. Every new acquaintance seemed like a key to a new adventure, an associate from whom I could learn more about Peru. I loved the feeling of being in a strange, unfamiliar place, a path wide open for me to build.

A reoccurring feeling during my first few weeks in Lima was confusion. Although I loved discovering the unknown and mysterious, being in a different country also came with the inevitable questions and constant wondering. How do you say this in Spanish? What does that word mean again? What time should I go to dinner? How do I use the shower? When is it appropriate to give a greeting kiss? Confusion, one prevailing state of mind throughout the journey, was something that I grew accustomed to quickly. Luckily, I was surrounded by patient, caring people who always explained to me the correct way to do things, say sentences, and perform tasks. Everyone I met was a teacher, and I, an enthralled student.

IV. THE INTERNATIONAL POTATO CENTER

On the following Monday, and for two months after that, I spent my working hours at the International Potato Center, (also known as CIP, the acronym for Centro Internacional de la Papa), which strives to relieve food scarcity in developing countries through scientific research on root and tuber crops such as the potato and sweet potato (Fig. 2). With scientists from over 25 countries, CIP was truly an incredible place to work, not only because of the number of remarkable scientists working toward one united goal, but also because of the immense cultural diversity and genuine openness of the staff.

Figure 2: Entrance to the International Potato Center, my host center.

Driving through the gates of CIP, I noted the lovely building and the unique architecture. I was greeted enthusiastically by my mentors at the Mycology laboratory, and immediately taken under the wing of Wilmer Perez, my main supervisor throughout my work at CIP. I learned that I would be dealing with the Oomycete *Phytophthora Infestans*, the causal agent of late blight, in my studies. Instantly, I was set to work reading pamphlets, publications, and books from the library regarding late blight and its effect on potato and tomato production.

V. RESEARCH STUDIES: *PHYTOPHTHORA INFESTANS*

Phytophthora infestans, a parasitic oomycete that causes the potato and tomato disease late blight, has been widely known for its most drastic effect on history: the 1845 Irish famine resulting in the death of over a million people. Ideal environmental conditions for the disease are temperatures of under 20 degrees C and between 905% - 100% RH. Once plants are infected, lesions appear on the leaves as light green to gray spots, and later expand into black rots (Fig. 3 and Fig. 4). Brownish-purple rots also develop on the tubers, along with sunken, spongy areas that later suffer secondary infection by fungi and bacteria.

Figure 3: Potatoes Infected with *Phytophthora Infestans*

Figure 4: Potato Plant leaf infected with *Phytophthora Infestans*

During my two months at CIP, I was involved in two projects. For the first project, I assisted Wilmer Perez and Soledad Gamboa in all the steps mentioned below, genotypically characterizing strains of *Phytophthora* of unknown species in order to receive base information on the migration of *Phytophthora infestans* and *Phytophthora andina*. On the second project, I conducted the research project alone that was assigned to me by CIP, testing the skills I had acquired through learning from my first study. I tested the Metalaxyl Resistance and mating type of several isolates of *Phytophthora infestans* and *Phytophthora andina.*

STUDY 1: GENOTYPIC CHARACTERIZATION OF *PHYTOPHTHORA INFESTANS*

Abstract

Fairly recent discovery of the A2 mating type has proved problematic for the control of late blight, as the A1 and A2 mating types produce strains with increased fitness and resistance through genetic recombination. This study sought to ascertain the genotypic identity of 27 isolates of *Phytophthora* of an unknown species. The genotype of the isolates was compared to that of Ecuadorian isolates of *Phytophthora Andina*. The 27 isolates indeed belonged to the *Phytophthora Andina*, and not *Phytophthora infestans*, which would have signaled a new migration of the A2 mating type into the country (Perez, *et. al*, 2001).

Introduction

Late Blight claims $2.75 billion of lost profit each year in the United States alone, and another $740 million are spent on fungicides that are not only detrimental to the environment but also damaging to human and animal health. Because of the threat that *Phytophthora infestans* poses to the livelihoods and economic stability of numerous countries worldwide, significant research to understand and control the disease has been conducted with reasonable success. However, the pathogen has concurrently found a way to resist former fungicides and methods.

Over the past two decades, the population structure of *Phytophthora infestans* has altered drastically, making it difficult to track and maintain suitable treatments for late blight. (Perez. *et. al*, 2002) The "old" population in Europe, the only type found before 1970, had only one mating type (A1) and one mitochondrial haplotype isolate (Ib). However, a new population emerged in the 1970's, comprised of both A1 and A2 mating types and Ia and IIa mitochondrial haplotypes. By the 1980's this "new" population had spread to almost all parts of the globe, causing the information once established about *Phytophthora infestans* to become outdated and presenting future difficulties for monitoring and preventing the disease.

As a result of the growth of the new population, the genetic variation, race diversity, and virulence factors all have increased tremendously. The diseases caused by new types demonstrate increased fitness, aggressiveness, and influence over potato and tomato cultivars. Due to the constant recombination of

genes from the two mating types, resistant cultivars are continually in danger of being susceptible to a more aggressive pathogen. Furthermore, oospores of the heterogeneous mating types can be latent in many environments, attacking crops at unexpected moments. Formerly useful fungicides such as Metalaxyl are also now powerless against the new population. Because of these problems, it is imperative that faster, more reliable strategies be developed to further research the changing face of *Phytophthora infestans* and determine the most effective way to combat the disease. Fortunately, modern techniques such as microsatellite analysis have vastly heightened the extent, effectiveness, and precision of research.

A secondary purpose for the project was to establish the use of Microsatellite analysis as a technique through which *Phythophthora* research could be more quickly and specifically researched in the Mycology laboratory at the International Potato Center. Because microsatellite analysis can draw out the frequent nucleotide repetitions in genomes, and because of the numerous alleles present in a microsatellite locus, microsatellites are ideal tools for recombination mapping and conducting genetic studies (Lees AK, *et. al.* 2006). Not only is the process less expensive and less time-consuming than procedures such as RFLP and AFLP, but it also is the only method that can provide clues into the relationship between different alleles. Therefore, the goal of this project is also to correctly develop a system through which future generations of scientists at CIP can employ the practice of microsatellite analysis for further research of *Phytophthora infestans*, from the protocols to the effectiveness of different primers.

Figure 5: Preparing DNA samples in the lab

In this study, 27 isolates of *Phytophthora* were taken from Peru and compared with 4 isolates from Ecuador. From Peru, six isolates were from wild potatoes, thirteen from cultivated potatoes, seven from tomato trees, and one from a cultivated tomato. From Ecuador, two isolates were taken from wild potatoes, one from a cultivated potato, and one from a tomato tree. Phenotypic structure

determination and RFLP testing had been previously conducted and had demonstrated a divergence between *Phytophthora* in Peruvian tomato tree plants and potato plants. However, the type of *Phytophthora* found infecting Peruvian tomato tree plants was unknown and required additional research in order to be confirmed. Because of its effectiveness in verifying the type of *Pytophthora* in tomato tree plants in Ecuador (*Phytophthora andina)*, microsatellite analysis was the ideal method to use to investigate Peruvian isolates (Chacon MG, *et. al.* 2006).

Isolates were first collected from infected leaves and reproduced in the laboratory where the sporangia produced were used to inoculate cultures in V8 agar plates. After lyphilization of the mycelium, DNA was extracted, amplified in a thermocycler, tested, and run through a polyacrilamide gel (Fig. 5 and Fig. 6). Primers used included Pi63, 2D, Pi89, G11, 1F, 4B, D13, and Pi66. Differing bands mirroring varying genomic structures could be seen from the isolates. The gel was then analyzed and scored according to the size of each allele obtained in each primer pair. Patterns in the data were revealed by the computer software NTSys, ultimately describing the relationships between isolates through dendograms and similarity coefficients.

Figure 6: Testing DNA samples in the lab

Materials and methods

Mycelium was first ground in liquid nitrogen for DNA extraction. 70 mg of ground-lyophilized tissue was added to 2 ml of extraction buffer and mixed by inversion, and then combined with 333ul of 5 M Potassium acetate, placed in a vortex machine and put on ice for 20 minutes. After the tubes were centrifuged

at 14,000 rpm for 10 minutes, the supernatant, 1600 ul of isopropanol was added and the mixture was set on ice for another 30 minutes. The pellet was then re-suspended in 1,400 ul of TE buffer. DNA quality and quantity was checked by electrophoresis on an agarose gel, by which it was determined to be acceptable for SSR analysis.

Results

Patterns in the data were revealed by the computer software NTSys, describing the relationships between isolates through dendograms and similarity coefficients. Results confirmed these isolates were in fact from the species *Phytophthora Andina*, whose 2 mating types have already been established. Further research, however, is necessary to conclusively determine that no A2 migration has yet occurred for the species *Phytophthora infestans.*

STUDY 2: MATING TYPE AND METALAXYL RESISTANCE

Abstract

Four isolates of a *Phytophthora* population (POX 117, 118, 119, and 120) belonging to the Solanaceae family were collected from cultivated tomato plates in the district of Quillazu, in Oxapampa, Peru b A. Parraga in May of 2007. Proper characterization was needed to determine the unknown species of the isolates and to facilitate further research. Experiments determining the isolates' resistance to Metalaxyl and mating types were conducted to begin characterization and classification of the isolates.

Introduction

Although both the A1 and the A2 mating type of *Phytophthora infestans* inhabits many parts of the globe, only the A1 mating type has been found in Peru. Since the 1970's, however, new lineages and sexual recombination populations have been found in more countries, leading to greater diversity in the populations and therefore more difficult disease control. This experiment was done to determine two fundamental characteristics of these isolates, leading to knowledge about their specifications and paving the way for further research. The Metalaxyl experiment describes the resistance of the isolates to formerly useful fungicides and provides insight into the changing wild populations of *Phytophora* that are becoming increasingly resistant to old methods of prevention. The mating type experiment classifies the isolates into A1 and A2 mating types (Knapova, *et.al,*

2002). If an A2 mating type is found, further research will be needed to determine the species of the isolate to determine whether the A2 mating type of *Phytophthora infestans* has emerged in Peru (Perez, *et. al,* 2001).

Materials and methods:

A. Metalaxyl Resistance Test:

A total of 36 agar plates of 10% unclarified V8 medium were prepared – three for each isolate at each of three concentrations. The common fungicide for late blight, Subdue 2E, was used, containing 25.1 % of Metalaxyl as the active ingredient. Subdue 2E was mixed into the agar at three different concentrations: 5 ppm (10 ul for .5 L), 50 ppm (100 ul for .5L), and 100 ppm (200 ul for .5L). Two agar circles measuring 1 cm in diameter were transferred to three medium plates at each concentration. The known resistant isolate PHU 76 was used as a control, as well as the known susceptible isolate POX101. Two additional isolates, PSR 006 and PSR 004, were also tested for Metalaxyl resistance, although they were not tested for mating type information. The isolates were then incubated at 18 degrees C for 10 days.

Figure 7: Transferring Mycelium onto V8 Agar Plates

B. Mating Type Test:

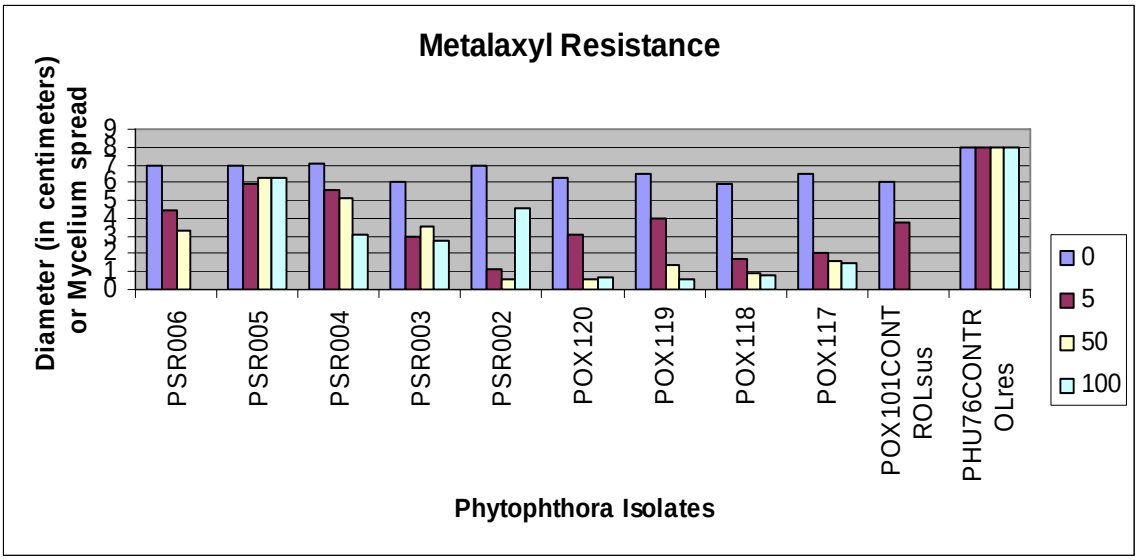
20 plates of clarified V8 agar medium were prepared. For each isolate, a circle of mycelium measuring 1 cm in diameter was propagated onto three separate plates along with a circle of the control isolate PHU 76, which has an A1 mating type (Fig. 7). Two additional plates per isolate were also prepared, each containing two circles (1 cm in diameter) of isolate mycelium. The isolates were then incubated at 18 degrees C for 15 days. After the incubation period, mycelium from the center of the plates containing PHU 76 and an isolate were observed and checked for Oospores. The existence of oospores would indicate the presence of the mating type A2, as the combination of A1 and A2 mating

types would result in sexual reproduction that is visualized through the appearance of oospores. The centers of the plates containing two circles of each isolate were also checked for oospores. The discovery of oospores in those plates would mark that isolate as homothallic.

Results

A. Metalaxyl Resistance Test:

The isolate growth was analyzed with a Metalaxyl resistance test developed by Forbes, G.A. Growth area that was > 40 % of the 1 ppm control at 100 ppm was considered resistant. Growth area that was < 40% of the 0 ppm control at 100 ppm, but was > 40% of the control area at 5 ppm, was considered moderately resistant. Growth that was < 40% of the o ppm control at all concentrations including 5 ppm was considered susceptible. Based on this test, POX 119 and POX 120 were moderately resistant to Metalaxyl, while POX 117 and POX 118 were susceptible. PSR 004 was resistant to the fungicide, while PSR 006 was moderately resistant (See figure below).



B. Mating Type Test:

Oospores were indeed present in the plates that contained crosses between each of the isolates and the control PHU 76 (mating type A1). Therefore, it can be concluded that the four isolates POX 117,118,119, and 120 have the A2 mating type.

VI. OXAPAMPA

During my time in Peru, my mentors at CIP organized a small expedition to Oxapampa. The purpose of the visit was to bring back samples of infected tomato tree plants and potato plants, but it was also was the perfect time for me to travel outside of Lima and explore the gorgeous regions of Peru. This was especially exciting to me, as I had hoped to see the more rural parts of the country. I, along with four CIP scientists, boarded the CIP van and started off, climbing the Andes slowly but surely.

The view outside started off gray; the morning was bathed in a foggy atmosphere typical of Lima. We soon reached the mountaintop – the highest point on the Andes, and stopped to take pictures. Unfortunately, my headache from the altitude prevented me from stepping outside the vehicle, but the view nonetheless was something to behold – just knowing that I was on the highest point of the mountain was a feat in itself. At this point, however, the journey was just beginning.

Figure 8 (Above) and Figure 9 (Right):
Mountain and Rainforest scenery in Peru

The winding roads, much more open than the traffic jams of Lima, led to a pace I was unaccustomed to – banking into each turn and holding onto my seat for dear life, I was both thrilled and frightened by the speed. Cliffs rose up above us from every direction, as we circled the enormous mounds of sand and stone (Fig. 8 and Fig. 9).

When we finally slowed down it wasn't because we were traveling dangerous mountain roads; instead it was because we had encountered new ground: unpaved mud roads, covered in gravel. Here the bumpy adventure began, as we, listening to the best sounds of the 60's disco, Texas-style country, and Spanish salsa, tried to remain seated on the uneven ride. The view, however, was worth the ride. Lush vegetation surrounded us on the mountainside, so dense that we couldn't see a few feet past it. Zigzagging dangerously with the mountain on one side and a steep cliff on the other, we squirmed through the one-lane pass.

I felt as if the whole world had disintegrated behind me. There, in absolute closeness with nature, I was at home. The clouds wavered overhead, so close I felt I could touch them, and no sign of the modern world could be seen through the trees. The air, rich and crisp, contrasted sharply with the cold, damp smog that hovered over Lima. The rainforest was a truly glorious place: a symbol of natural beauty.

Driving from farm to farm in the countryside, we were about to lose hope when finally we found a family that led us to their tomato tree plot. Many of the other tomato tree plants were not in growing season, so finding them was especially rare at that time. However, we were in luck. An old woman greeted us warmly at the door, and, after we explained to her our scientific purposes for seeing her plants, she led us up the steep mountainside to her farm high above.

Figure 10: The owner of the farm, who led us up the steep mountainside to her farm and tomato tree plants.

Climbing the mountain was a test of endurance and nerves. As the slope steepened beneath me, I was filled with awe as I followed our only guide: the old woman. With an enormous blade in hand, she cut the unruly brush out of our paths, neatly slicing apart thin branches and overgrown leaves. The mud slid and sloshed beneath our shoes, and we, inexperienced climbers, held onto trees for dear life as we progressed up the mountainside (Fig. 11). The woman, with her black rubber boots, never hesitated for a moment - she must have climbed these slopes every day for years (Fig. 10).

Figure 11: Soledad Gamboa, a mentor from CIP, and I climb through the dense vegetation of the rainforest in search of tomato tree plants.

After what seemed like hours of climbing, we reached a cluster of tomato trees. Sure enough, many of the leaves exhibited the signs of blight produced by *Phytophthora andina*, a relative of *phytophthora infestans.*

Finally fulfilled in our mission, we were ready to head home after three long days on the road. Behind us, the serene country landscape masked the hard life of the farmers who lived in what seemed like paradise (Fig. 12). Along the way I asked a multitude of questions to my mentors: how did the children go to school? How were the crops taken to the market? Their answers astounded me.

In many such places, no school was available, and if there was a school, children often had to walk miles in mud and mountainous roads to reach it. The crops were not sold commercially; instead the farmers lived off of the land, feeding only their families. I felt immensely touched by the strength of these farmers, sensed a pride for the bit of help I had done to ease their troubles, and pledged that one day I would be able to do more. However, though progress to the area could bring modern conveniences, I knew it would also be detrimental to the heavenly rainforest, brining devastation to the wonder of the Peruvian rainforest.

Figure 12: a small house by the mountain road.

VII. REFLECTIONS: LIMA, PERU

While listening to the 2006 Borlaug-Ruan interns at the Youth Institute, I remember hoping to be placed in Peru in order to study the enormous income disparities between classes. After the conference, as I read about the profound divide, I intended to study the sociological and political aspects of food scarcity, a topic that especially interests me.

However, once I arrived in Lima, I realized the weight of both my responsibility and the responsibility of those taking care of me, as I was still 17 and under the protection of others. This was especially hard for me, a naturally independent and adventurous youngster, always itching to discover new things. After returning from work, I would read alone in the apartment, unable to leave without accompaniment. Although I enjoyed the company of the Bartolinis, who took me out on various occasions, I found that it was impossible for me to truly study the urban poor, those who lived in the slums of Lima.

I felt extremely lucky to be given the best of the Peruvian world: my own apartment in a classy neighborhood in San Isidro (Fig. 13), one of the wealthiest parts of Lima, a job situated in CIP, located in La Molina, care from a wonderful family and delicious meals prepared by two maids, and a car ride to and from work. Although immensely grateful for my living and work situation, I could not help but to feel ashamed: I, who wanted to study income inequality and economic depression of the slums, was completely blind to the real situation in Peru. Whenever I was taken out to walk in Lima, I was led away from the dangerous zones, guided into sparkling shopping malls instead of muddy streets and torn-down buildings.

Figure 13: The interior of the Bartolini's house – an elaborate living room in a large house situated in a wealthy district of Lima

Though my age kept me from in-depth research of the social and political aspects of poverty in Peru, I am thankful for all those who took care of me and made sure that I returned home safely. In a way, I learned about poverty without seeing it, in fact, it was through being led away from the slums that I realized the true situation of the poor, and the reasons that I was shielded from the scene.

While riding inside of an air-conditioned, radio-blaring car, I could see mothers toting their babies, walking to car after car parked at a red light, trying to sell some candy or a newspaper. I saw mimes (Fig. 14) and gymnasts, dangerously performing at intersections, hoping that some passer-by will toss them a coin. Beggars lined the streets, invisible to upturned noses, and pickpockets waited with glimmering eyes outside darkened alleyways (Fig. 15).

Figure 14: A mime performs for parked cars at a red light in downtown Lima.

Figure 15: Slums in Lima, Peru

I have realized that although I have received a glimpse of the hardships in Peru, I have much yet to learn. I hope to return to the magnificent country one day, in order to feed the hunger that now grows inside of me to reduce the poverty and evident in many parts of Peru. Between the crowded, noisy streets of Lima, and the serenity of the rainforest, the phenomenal divide between rural and urban Peru is obvious. I am blessed to have been able to see both worlds and to, on some level, understand the hardships encountered by those living in both regions.

VIII. CONCLUSION

Throughout my two months spent in Peru I have learned a great deal about potatoes, *Phytophthora*, but, above all, about people. It has truly been an adventure; memories paved through discovering the rich Peruvian culture, the influences connecting every country, and, lastly, myself.

From the first moment I stepped off the plane I began to make associations in my brain, weaving images and thoughts together. I noticed how the streets reminded me of China, how the sidewalks seemed like those in Taiwan, how the brush of the rainforest was like that in Uganda, Africa, and how the billboards seemed strikingly reminiscent of the States. I saw these cultural influences as a mesh, a bonding web that forms our entire world, factors influencing the development of a country just as nurture influences the development of a child. I saw that growth, a movement toward an ideal, must not simply ignore the past or the shrinking present of a country. The poor cannot be forgotten or ignored, just as the poverty of a country is what most needs to be fixed, not obscured.

I feel exceptionally lucky for so many reasons; for this chance to learn about science, the world around me, and my inner self. I believe that the best time to mull over my own life is in a world separated from my past. In Ames, Iowa, a city I have lived in for over ten years, I find that my thoughts have become muddled with my environment. They are contaminated by some twisted associations with school, classmates, family, and the simple knowledge of familiar faces and places. In a foreign country, however, strangeness allows for perfect self-discovery. Completely removed, the mind is at ease to see within, untainted emotions, unambiguous ideas, true introspection.

Through my time spent alone on tired afternoons, I have done more than ponder the situation of Lima's rural and urban problems. I have dissected my likes and dislikes, dreams and aspirations, passions and convictions, past and future. As an overwhelmingly busy student, very little time that I have at home can be allotted to sheer *thought*, and it is this time for thought that indeed has allowed for the largest amount of personal growth.

Though the scientific component of the internship was truly invigorating, the cultural aspect of my two months in Peru produced the toughest challenges and the fondest memories. The interactions with both companions and strangers I have encountered in unfamiliar situations have changed me in unbelievable

ways. There is no experience in my mind that is more powerful than my two months spent in Peru, and for that, I sincerely thank everyone who gave me this amazing opportunity. This period of learning will never leave me, and I can only hope to dedicate my life as strongly and as passionately to the honorable cause of achieving food security as those who have come before me, pursuing until the end this imperative goal.

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Thank You

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