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Volume 8  
Fall 2009

Stanford Undergraduate  
Research Journal

# SURJ



# SURJ

Stanford Undergraduate  
Research Journal

Volume 8, Fall 2009

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# Editor's Note

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In this eighth issue of the Stanford Undergraduate Research Journal (SURJ), we are pleased to present exemplary undergraduate research completed at Stanford and other universities nationwide. As the unique student organization at Stanford disseminating work in all fields of academic study, SURJ continues to highlight important student discoveries in the humanities, social sciences, natural sciences, and engineering.

As in past issues, we include both peer-reviewed content and special features written by our staff describing promising ongoing research. Our student reviewers are among the most accomplished students on campus. With their careful attention as well as guidance by faculty and professional advisors, we have chosen a diverse set of articles to share with the SURJ readership. While we are disappointed not to have the means to publish all submissions and proposed articles, the contents of this issue reflect the breadth and meticulousness of undergraduate work at Stanford and elsewhere.

In addition to choosing content to publish, our editorial staff spent the past school year working tirelessly to improve the organization of SURJ and our relationship with our readers. For the first time, part of the editorial process was carried out online using the Open Journal Systems engine. In future years, we hope to use computerized tools more extensively to streamline the submission and editing processes and maintain a completely “double-blind” submission process. Additionally, over the past year, SURJ was distributed at every major undergraduate research symposium on campus. Stanford’s admissions office also distributes SURJ to prospective students interested in research, and each issue is catalogued and archived by the Stanford library.

SURJ annually attracts national attention as a professional-quality journal with editorial and review processes carried out entirely by students. We have maintained contact with staffs organizing new research journals on other college campuses and are pleased to serve as one of the first and most successful models of such a publication. This level of professionalism reveals the value of including undergraduates in the research process; the energy and rigor exhibited by our staff and contributors brings new perspectives to ongoing research and ideas for new lines of inquiry.

On behalf of the entire 2008-2009 SURJ Editorial and Production staff, we would like to thank you for taking the time to peruse the Spring 2009 issue. Only with your support can we distribute such an important publication to every undergraduate residence, library, and academic department on campus.

Sincerely,

Andy Ho and Justin Solomon  
Editors-In-Chief 2008-2009

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## Special Features: An In-Depth Look at the Research Process

Most peer-reviewed journals focus only on original research articles, critiques, and reviews. They emphasize the results of academic research as well as the materials and methods that prove the research is scientifically, historically, or otherwise sound. While SURJ understands the value of publishing academic articles, we also believe in telling the story behind the research.

It is for this reason that we include the Special Features section in our journal. This section contains a collection of articles about student researchers and their experiences selecting a mentor, designing a project, carrying out experiments, and collecting data--the processes without which there would be no final, publishable results.

In this issue, you will read how Sergey Levine's enthusiasm for a computer science course on virtual worlds inspired him to create software in which an avatar responds to human speech. You will learn how research conducted for a PWR paper on the International Space Station piqued the interest of Jon Merola and led him to seek a research group that focuses on microfluidic devices. You will read how Fred Wolens's research on the effect of college football on election results has led him to consider writing an honors thesis about professional sports and voting. You will read about the combination of chemistry and hands-on work that attracted Armen Petrosian to his project on synthetic diamond films. Finally, you will hear Jeff Jensen, a senior studying electrodeposition, talk about the frustrations--including competing chemical reactions--that student researchers must handle.

It is our hope that by putting a "face" on the research conducted by our undergraduates, we make research opportunities more accessible to those students who have not yet joined labs or research groups. It is important to acknowledge that all of the researchers featured in this issue have different academic interests and post-graduate plans, yet each found that research enriched his undergraduate career.

Please enjoy reading the Special Features section in this issue of SURJ. We expect that you will be as impressed by the persistence and enthusiasm of the undergraduate researchers as you are with their projects' results.

Sincerely,

Jennifer Levy and Karis Tang-Quan  
Editors, Special Features

# Spotlight on Sergey Levine: Automatic Generation of Avatar Gestures

Karis Tang-Quan<sup>1</sup>

Second Life. Keneva. Cybertown. Moove. The list of virtual worlds continues to grow as more and more users subscribe to the relatively new pastime of virtual reality. The increasing number of subscriptions means the creation of more three-dimensional avatars, or a computer user's alter ego in the virtual world. This popularity of avatars calls for better character animation, including body language animation. Sergey Levin is answering this call.

Working in the Department of Computer Science, Sergey has completed a project on the automatic generation of gestures for avatars in virtual worlds. Since gestures and body motions are an important part of human communication, Sergey felt it was vital to include these interactions in the virtual environment as well.

The result is that avatar interactions would be closer to the actual interactions that go on between human beings. As is expected with computer science projects, Sergey's research methodology deviated from the typical natural science experimental design or humanities readings. In the end, Sergey's work produced results in the real world for the virtual world.

First, Sergey, with the help of his research group, recorded a body of motion capture data. The data were segmented in a way to generate relationships between speech and the occurrence of common gestures. A probabilistic model was then trained to exploit the found relationships. By using the common relationships, this probabilistic model selects the appropriate motion to match a new speech signal. The system of the probabilistic model was designed to flow accurately and smoothly from gesture to gesture based on the current speech.

Real people evaluated the model by comparing the synthesized motions to the motions of real human beings. Using a hidden Markov model, Sergey was able to create a well-trained probabilistic model for his project.

With this probabilistic model, Sergey then

wanted to create a human character that had body gestures to match his or her spoken words. Not only would the gestures match the speech, but also the system would run in real-time with no knowledge of future phrases. The probabilistic model would be able to predict the appropriate future body movements based on its inferred data from the current speech. The timing and rhythm of the body gestures would correspond with the character's speech, bringing life and reality to animated characters.

Giving life to animated characters is not an easy task. Sergey not only became an expert in his computer science field of study but also trained to understand linguistics, psychology, artificial intelligence, and animation. Since gesture synthesis is so interdisciplinary and Sergey began with a background in computer graphics, he accumulated a vast amount of knowledge through the course of one research project. Though it has been a challenge for him, it also provides the greatest reward: the understanding of unfamiliar subjects and original research.

The challenge of research has taught Sergey that an undergraduate research experience is, in his own words, "humbling." Despite having a solid background in computer science and having taken numerous Stanford courses, Sergey realized how much he still has to learn. Research is not all about the end product, but what discoveries were made along the way.

Through his research experience, Sergey has realized the importance of reading the right articles and books and having those perfect conversations with key people that can stimulate ideas. Creativity and problem-solving skills provided the foundation for starting research, but the people around him made it possible to complete the project.

Sergey found support for his project in the Virtual Worlds Group in the Computer Science Department. The head of the group Professor Vladlen Koltun realized Sergey's interest and ability for research in a class on Virtual Worlds. It was through this class that Sergey saw the research potential of networked virtual environments. Naturally Professor

<sup>1</sup>Stanford University



Figure 1: Automatically generated body language corresponding to speech for human avatars in the virtual world.

Koltun, knowing that Sergey can meet the challenge of a broad, interdisciplinary subject, suggested Sergey join the Body Language project. It was a perfect match for Sergey to be involved in the development of new technologies that are currently being applied.

While receiving guidance from graduate student Jerry Talton in the Virtual Worlds Group, Sergey began working on the growing project. As his project expands, Sergey incorporates new people in his research. In addition to direct contact with Professor Koltun, Sergey works with Visiting Assistant Professor Christian Theobalt in the Artificial Intelligence Lab, trying to incorporate more sophisticated AI techniques in his project. Previously, Sergey has worked with the Stanford Biomotion Lab and Animate Inc. to integrate an interdisciplinary approach to his research.

While the number of virtual world users growing, Sergey continues his research on generating the appropriate body gestures for human characters. He hopes that his work will be applied to virtual environments that lack the multi-modal aspect of communication that happens in the real world.

Recently, Sergey submitted his research work for publication and looks forward to hearing back. His current and future work includes an extension of the current system that trains the model. This improved system would reveal further insight to the correlation between motion and speech. These revelations are necessary for providing realistic character animation in the virtual world and vital information on

behavioral interaction in the real world.

Through his humbling experience with interdisciplinary research, Sergey has learned an immense amount on human interactions through body motions. With this understanding, Sergey does not need a Second Life to give life to animated human characters.



Sergey Levine is a senior in the Department of Computer Science. Originally from Moscow, he currently resides in Redmond, Washington. He looks forward to entering the Stanford PhD program in computer science after graduation. He enjoys being an active member of the Stanford Fencing Team.

# Spotlight on Jonathan Merola: Developing a Microfluidic Device for Sorting and Culturing Cells

Karis Tang-Quan<sup>1</sup>

Research has been one of the greatest learning experiences at Stanford for Jonathan Merola. He desires to understand science beyond what is taught from the textbook and in the classroom. To pursue this cause, he has used past summers to extend his research work outside of the academic school year. Jonathan pushes the limits of the research frontier with his work on microfluidic chips.

Initially, Jonathan was intrigued by the subject of astrochemistry. Through his Program in Writing and Rhetoric (PWR) course, Jonathan learned more about the International Space Station. The paper on the International Space Station provided the necessary link for Jonathan to learn about the ongoing astrochemical work in Professor Dick Zare's lab in the Chemistry Department. With the goal of learning biologically-applicable techniques and gaining lab experience, Jonathan began his research work with Professor Zare's group.

Jonathan's research focuses on creating a microdevice to sort and culture single cells based on their size and shape. A second device analyzes the genetic and protein content of the same cells. These two devices are then coupled to isolate cell characteristics of particular interest. Jonathan's study is relevant to current research because scientists, biologists especially, are constantly looking for optimal cell sorting devices. By designing and fabricating microfluidic devices, Jonathan hopes to be able to contribute to the understanding of how different types of bacteria are able to adapt to their environment on a genomic and proteomic level.

Jonathan employs methods such as pinched flow fractionation (PFF) and deterministic lateral displacement (DLD) to sort cells by size on his microfluidic platform. PFF uses the physics behind the velocity of moving particles and flow streams to separate cells. A special feature in Jonathan's microfluidic sorting device is asymmetrical branched channels for collecting the separated

cells. Asymmetrical PFF is used to achieve greater resolution of size separation. However, Jonathan did not only focus on asymmetrical PFF. DLD was also utilized as a method to fractionate cells. DLD is dependent on laminar flow properties of the channels to provide size-dependent particle sorting. In DLD, fluid streams flow through a matrix with cells shifting positions through the stream lanes. Collecting the outflow of the matrix shows separation of the particles with differing radii.

PFF and DLD are only two physical fractional methods in Jonathan's microdevice. His research also includes the effect of pressure and electro-osmotic flow (EOF) on the potential to use PFF and DLD in microfluidic sorting. While EOF presented challenges in DLD, it was found to improve resolution of PFF results. Jonathan remains hopeful in integrating these filtration systems in more complex devices. When EOF was used in the DLD method, Jonathan met challenges regarding cell adhesion. He couples his research on cell-sorting device with a study of cell

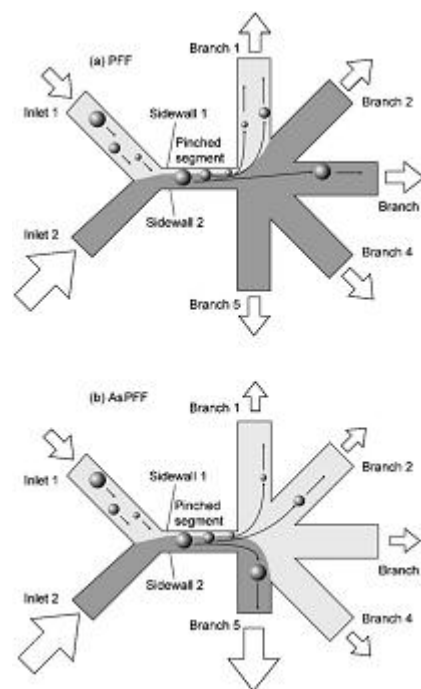


Figure 1: Comparison of (a) pinched flow fractionation (PFF) and (b) asymmetric pinched flow fractionation (AsPFF).

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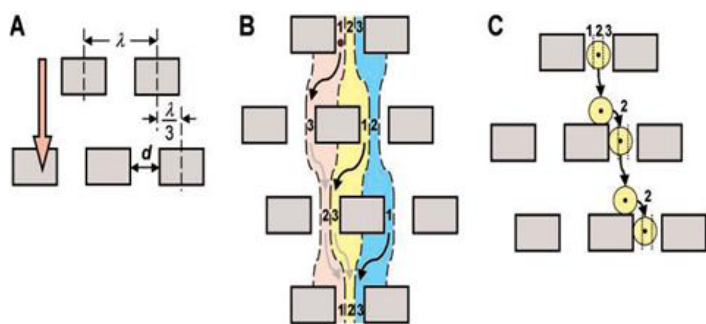


Figure 2: Deterministic Lateral Displacement. (a) Fluid flows vertically through a series of obstacles offset by a distance,  $\lambda$ . (b) Three fluid streams do not mix as they flow through the matrix. Small particles follow these streamlines, exhibiting zig-zag motion as they shift positions through the matrix. (c) Particles that have a radius larger than one of the lanes are displaced as they enter subsequent gaps.

culturing on a microfluidic chip. Using primarily poly-(dimethylsiloxane) (PDMS), Jonathan is fabricating a chip for culturing cyanobacterial cells under the condition of continuous flowing media.

While Jonathan has come a long way in his research on the cell sorting methods of his microfluidic device, he has exceeded even his own expectations. Having started his project studying on cyanobacteria, he has applied microfluidic approaches to studying *Celiac Sprue* disease, and is currently involved in biochemical research at the medical school. Celiac disease is a digestive disease that damages the small intestine and inhibits the absorption of nutrients from food. Jonathan wanted to find biological applications of his research, and now has found that his research can be applied in many settings, including medical clinics.

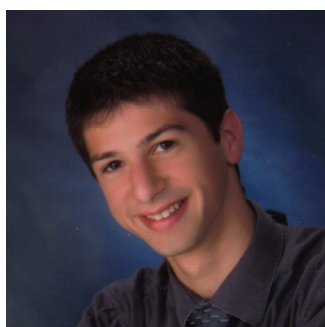
Jonathan envisions the widespread use of microfluidic devices in the future. Such devices can be used in clinical diagnoses, ecological assays, and metabolic and pharmacological studies. Through

the culture and analysis of single cells on a single chip, scientists can know more about evolution on the molecular level. Just as he had hoped, Jonathan is contributing to the expansion of scientific knowledge.

Another personal goal that Jonathan achieved is learning how research is really conducted, a lesson that all scientists realize. Research was not always positive results. Jonathan had to run many of the same trials to ensure accuracy and precision. He spent hours fabricating one microdevice that was used within minutes. Still, Jonathan put the necessary work into the research he so enjoyed. Now he is able to see the benefit from his long hours in the laboratory. His creation can be applied in ways even he did not imagine.

In the lab, he gets to work with graduate students Samuel Kim and Eric Hall who contribute so much to Jonathan's understanding. As Chairman of the Chemistry Department, Professor Zare provides Jonathan with great resources and mentoring not just during the academic year but also throughout the summer when Jonathan worked. Jonathan's project was made possible by the contributions of these scientists as well as the Chemistry Department's Bing Summer Fellowship. This funding opened up a key opportunity for Jonathan to go in depth in his research. Without the support of his mentors and the Chemistry Department, Jonathan would not have been able to make the scientific strides that he has.

Beginning with a PWR paper on the International Space Station and ending with a microfluidic device for diagnosing diseases, Jonathan has exceeded his own research goals and gained invaluable research experience.



Jonathan Merola is a senior majoring in Chemistry and minoring in Biology at Stanford. Originally from Natick, Massachusetts, he plans on continuing to be involved in research over the summer and hopes to attend medical school in the Fall. In his free time he enjoys playing the bass with his band Ampersand, and visiting with patients as a volunteer at the Stanford Cancer Center.

## Spotlight on Armen Petrosian: Structural and Thermal Characterization of Synthetic Diamond Films

Jen Levy<sup>1</sup>

As the mp3 player continues to get smaller, the laptop thinner and the cell phone lighter, questions as to the physical limits of these devices become more salient. What restricts the size of our favorite electronics? Is it the capacity to manufacture such small parts? The ability to assemble such tiny pieces? According to Armen Petrosian, a junior studying Materials Science and Engineering, the limiting factor is actually the ability of the computer chip to dissipate heat.

This is why, most recently, manufacturers have started toying with coating the chips with diamond, the best known thermal conductor. Heat spreads quickly through the material due to vibrations in the dense crystal lattice. Without the diamond coating to distribute the heat, the chip would melt and the device would become nonfunctional.

For economical reasons, the most widely researched coating is synthetic diamond film, made by the process of Chemical Vapor Deposition (CVD). However, the artificial diamond often has deformities not found in natural diamond, which limits its heat-spreading ability in electronics.

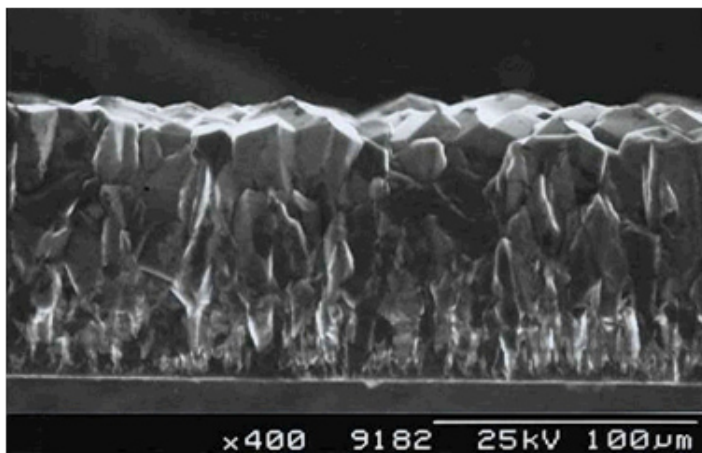


Figure 1: Columnar growth of polycrystalline CVD diamond is evident in this SEM cross-section ([www.chm.bris.ac.uk](http://www.chm.bris.ac.uk))

Armen, working in the lab of MSE chair Dr. Robert Sinclair, spent last summer investigating the relationship between the quality of the synthetic diamond and its thermal conductivity. The research was in collaboration with Element Six, an industrial diamond manufacturer owned by De Beers. Element Six provided Armen with the CVD diamond samples, which he cut, examined, and analyzed.

Armen used a focused ion beam to slice the samples into small enough pieces that their details could be observed using Transmission Electron Microscopy (TEM). The image produced by TEM provided him with such a precise picture that individual columns of atoms could be seen.

“We found that slight differences in the CVD method had a large impact on the thermal conductivity of the film produced,” explained Armen. Small changes in the growing process such as temperature or duration might affect the dislocation density, a measure of deformities in the diamond. A single row of atoms that was misaligned or missing from the lattice could be detected.

Armen found a strong correlation between the logarithm of the dislocation density and the thermal conductivity. With this information, Element Six will be able to adjust the CVD process in order to maximize the heat-spreading ability of the diamond film.

Although the use of artificial diamonds is

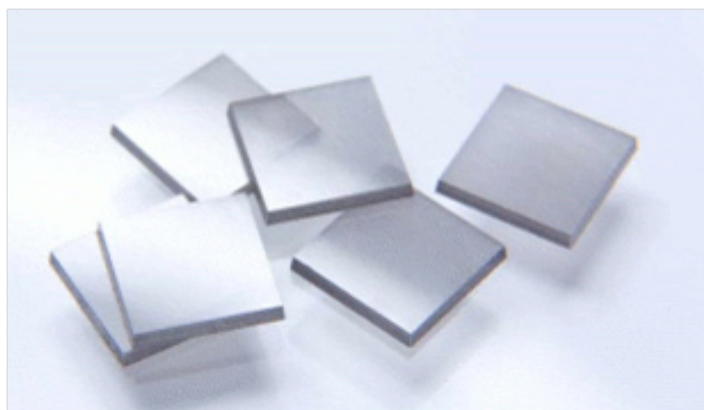


Figure 2: Commercially available CVD diamond films from manufacturer Element Six ([www.e6.com](http://www.e6.com))

<sup>1</sup>Stanford University



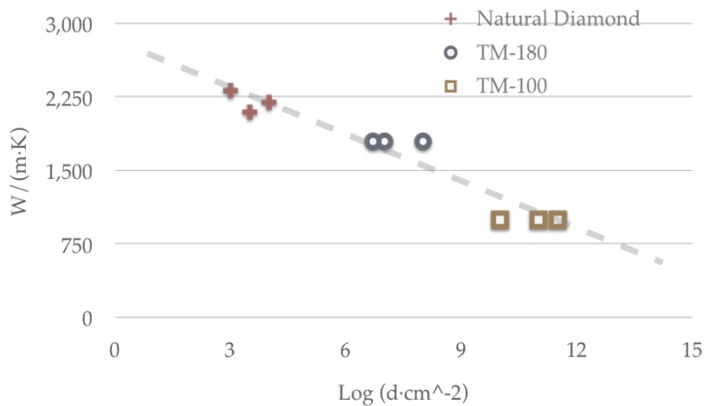


Figure 3: A strong correlation was found by graphing the log of the dislocation density of the films with their respective thermal conductivities, underscoring the damaging effect of crystal defects on phonon mean free path in CVD diamond.

very common in industry, there has not been much research on their structure simply because the tools to study them are not widely available. Stanford provided Armen with the Dual-Beam Focused Ion Beam (FIB)/Scanning Electron Microscope (SEM) system to slice the samples and the TEM to observe them.

“Using the ion beam for this purpose is a new technique, and it required about thirty hours of training,” Armen recalled. “This is not research you can do just anywhere. Stanford provides unique environment. Here we have really advanced equipment to use and exceptional professors and mentors to guide you.”

Armen says that his graduate student mentor, Joon Seok Park, and his advisor, Sinclair, provided him with invaluable assistance. “Without them this project would never have been possible. I had worked on two research projects prior to this one, but this study was much different because it was at Stanford. The people here really know what they are doing and are eager to help undergraduates,” Armen said.



Armen Petrosian is a junior majoring in Materials Science and Engineering, with a concentration in energy technology. He is originally from Armenia, but attended high school in Washington, D.C. In his free time, Armen likes to snowboard and play basketball.

He found out about the project through the MSE Undergraduate Summer Research Program. It was funded through a grant by VPUE.

Although he had a list of projects from which to choose, Armen says this particular one caught his eye. “Diamonds was the key buzzword for me,” he said. “We all know that diamond is very strong and has interesting optical properties. What I didn’t realize was that it could dissipate heat hundreds of times more effectively than most other materials.”

At the end of the summer, Armen participated in the MSE colloquium, where he presented his research. “I liked showing my work, but it was even more awesome getting to see what other students in the department were doing,” he said.

Although Armen does not know if he will go into the research sector of MSE, he feels the tools he learned will be invaluable for any direction he takes. “Most of all,” he added, “I really enjoyed the experience. I like chemistry and working with my hands. The project seemed like a good combination of some of my interests.”

# Spotlight on Fred Wolens: The Impact of Cloud Cover and Football Games on Election Results

Jen Levy<sup>1</sup>

Can cloud cover on Election Day be used to predict the next governor? What can college football games tell us about the next presidential race? These are questions that motivate Fred Wolens, a junior in the Political Science department, in his ongoing research on Retrospective Voter Theory.

Retrospective Voter Theory assumes that voters will choose to re-elect—or not to re-elect—an incumbent based on how satisfied they are with the candidate’s previous term based on economic or other policy related achievements. Another factor that influences the decision is the voter’s prediction as to how well other candidates would perform if elected.

But, according to Fred, voters do not always act this reasonably.

“My research demonstrates that voters are acting neither retrospectively nor prospectively, but merely out of irrational motives. This shows that they are not always rational voters and are acting purely as a result of personal feelings,” explained Fred.

Under the guidance of Dr. Neil Malhotra, Assistant Professor of Political Economy in the Graduate School of Business, Fred has gathered the results of the presidential, gubernatorial, and senatorial elections since 1960. He is studying the effect of two factors on the outcomes of these elections: NCAA Division 1 football game results and cloud cover.

In order to analyze the effect of the football results, Fred assigned each D1 team to a county (the level at which the election data is delineated). For example, the election returns of Santa Clara County were linked to the results of the Stanford football games. Fred, who is currently analyzing the preliminary results, found that counties in which the home football team won the previous Saturday’s game were more likely to reelect the incumbent.

“In fact, the correlation between a team’s win and the reelection of the incumbent is so strong that it is sort of unbelievable,” said Fred. The surprisingly strong correlation has led Fred to question whether

confounding variables have skewed his findings.

“It is possible that some other factor might be coming into play,” Fred admits. For example, a college football team might be successful because the city in which it is located is thriving as a result of the strategic policies of the current mayor. “It is very difficult to isolate a single variable in this case, but we are working on getting rid of some of the noise” he said.

Fred is looking not only at the winner of the Saturday game but also at the score of the game and the overall season record of each team. There are plans to analyze whether a win on the previous Thursday has a similar or weaker effect on an incumbent’s probability of being reelected. Fred is also using the post-election games as control tests to see whether these yield any significant results.

Fred has been collaborating with Professor Andrew Healy at Loyola Marymount University. Dr. Healy was initially motivated to pursue research in this area after hearing an anecdote about the 1969 New York City mayoral election in which the incumbent, John Lindsay, managed to win after being very far behind in the polls. Lindsay’s re-election has been attributed to his campaign’s references to the “Amazin’” Mets, who, despite ranking ninth place in their ten-team league, managed to win the World Series.

“Lindsay got a huge bump in the polls following the World Series win, leading us to consider this effect across other sports,” Fred said.

Fred is also in the preliminary stages of a study on the effect of cloudy skies on election results. “I am looking at data from over 1200 weather stations as well as information collected by the National Climate Data Center,” he said.

“Unfortunately, there is a wide range of standards of data from some of these weather stations.” He says that some old reports are about as reliable as “mom and pop outside in the rain with a jar and a ruler.”

Fred acknowledges that there are many factors besides cloud cover that may distort his results. “Papers have been published that show that voter turnout for Democrats is much lower in the rain because of various socio-economic factors. In order

<sup>1</sup>Stanford University

to minimize the effects of weather variables that may affect turnout, we are controlling for rain and temperature in my study.”

Fred is constantly adding new control variables, like temperature and wind speed, to make the data more reliable and a better fit. “There are a lot of factors to control for, and sometimes the work can be very tedious. But it is really satisfying to see the progress we’ve been making.”

Fred says this project, which he calls his “first foray into research,” is a lot more rewarding than he expected it to be. “It is really exciting to have original work,” he said.

Fred began this project in April 2008 after hearing that Dr. Malhotra, then working in the undergraduate Political Science department, was looking for a research assistant. “This project really indulged my inner cynicism,” admitted Fred.

Fred is considering using the topic of this project as a springboard for a co-term or honors thesis. “I would particularly like to look at how voters’ decisions are influenced by professional sports, as well” he said.



Fred Wolens is a junior pursuing a major in Political Science and a minor in Communications. He is currently an RA in Burbank and describes himself as an "avid music historian." Fred is originally from London.

# Liberalism Manifest

Jon Canel<sup>1</sup>

Historians have long understood modern American liberalism as a direct descendent of the Lockean political tradition articulated in the Two Treatises of Government. Although American conservatives would claim Edmund Burke as their ideological forbearer, the conservative remains equally, if not more committed to the strict protection of property rights that characterized Lockean political theory than the liberal. This essay proposes an alternative vision of modern American liberalism. It argues that American liberalism is not Lockean. It sees the Declaration of Independence as the origin of the modern liberal tradition, which contends that government functions to facilitate the “pursuit of happiness.” Whereas the conservative correlates individual autonomy with a zealous protection of private property, the modern liberal holds as inalienable the right of each individual to pursue the ends of self-determination and self-actualization.

A political ideology requires an identifiable historical origin in order to inform its practical function and determine the theoretical end toward which it aspires. Unfortunately, because no widely accepted manifesto of modern liberal ideology exists, liberalism has subjected itself to gross distortions. Even Barack Obama—the purported twenty-first-century standard-bearer of the liberal political cause—has attempted to subsume his commitment to canonically liberal policies in a pragmatism adverse to ideology.

Modern American conservatism, on the other hand, has attempted to fashion itself as a coherent theoretical system. Although the connection between a classical conservative thinker like Edmund Burke and the modern Republican Party might at best be described as tenuous, the work of conservative intellectuals such as Russell Kirk provided a foundation from which figures like Barry Goldwater and William Buckley could articulate a “conservative” political platform that challenged the post-New Deal liberal status quo of the mid twentieth-century. If conservatism possesses both a clear historical antecedent and a set of essential, definitional convictions, it would stand to reason that liberalism, its self-avowed antithesis, should as well.

Many political historians have identified John

Locke as the originator of the American liberal tradition. In his discussion of the New Deal, Louis Hartz goes so far as to argue that the “radicalism” of the New Deal lay in its implementation of a welfare program in which the “American Lockean faith” smothered any serious socialist challenge (Hartz 261). Locke’s vision of a society in which government is obligated to protect the life, liberty and property of its subjects certainly distinguishes Lockean liberalism from the collectivism of Marxism or socialism. However, it offers little by which to distinguish the modern American liberal from his conservative counterpart. Both the liberal and the conservative regard life, liberty and private property as inalienable American rights. Though conservatives like Buckley argued that “the growth of government must be fought relentlessly,” liberal reforms of the twentieth-century never threatened to nationalize the means of production and eliminate private property.

As on the issue of property, the liberal cannot adequately distinguish himself from the conservative by claiming to better represent a Lockean commitment to life and liberty. Although John Dewey asserted that liberalism endeavored to “liberate” the individual, Barry Goldwater also identified the preservation and extension of freedom as the “first concern” of the American conservative (Dewey 323; Goldwater 6). Even Edmund Burke, the proclaimed “founder” of modern conservatism, remained deeply committed to the protection of individual autonomy through the protection of private property. According to Russell Kirk, the Burkian conservative perceives freedom and property as “closely linked.” By advocating the protection of private property rights, Kirk sought to safeguard the liberty of the individual from the propensity of a Leviathan state to become “master of all” (Kirk 8).

Thus, modern liberalism finds itself in the predicament of being unable to distinguish its ideology from that of the conservative so long as it claims John Locke as its genitor. Unlike the conservative who equates individual autonomy with the protection of private property, the liberal recognizes as inalienable the right of each individual to aspire toward self-determination and self-actualization. The ultimate function of government lies in its capacity to facilitate the “pursuit of happiness,” as happiness comprises

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both the purpose of life and the object of liberty. The Declaration of Independence marks the critical point of philosophical divergence between modern liberalism and Lockean values. The liberal understands happiness as a fundamental right, and as a consequence, does not permit an unshakeable faith in the sanctity of private property to rule his interpretation of the Constitution and impede the welfare of the nation's citizenry.

According to Locke's *Two Treatises of Government*, "Government has no other end, but the preservation of property" (Locke 329). Such a characterization of government differs substantially from the perceptions of most twentieth-century American liberals, who appeared more sympathetic to John Dewey's definition of liberalism as the "liberation of individuals so that realization of their capacities may be the law of their life" (Dewey 323). Like Dewey, Franklin Roosevelt argued that government existed foremost to protect rights of "personal competency," such as free thought, free speech and free "personal living" (Roosevelt 746). Because he understood the laissez-faire economic policies of the early 1930s as "steering a steady course toward economic oligarchy," Roosevelt believed such protections of property must be revised, "not to destroy individualism, but to protect it" (Roosevelt 746-751).

Dewey conceded that, at one point, Lockean classical liberalism may have effectively safeguarded personal competency (Dewey 326). Yet, with the rise of corporate Goliaths in the late nineteenth-century, economic interests assumed the "coercive power" and "violent force" previously regarded as the reserve of a political state. Some early twentieth-century liberals would persist in defending their opposition to corporate interests under the pretext of protecting traditional property rights. Walter Lippmann, for instance, argued that ownership interests in public stock companies bore no resemblance to Lockean land rights, and as a consequence, did not merit the protections traditionally afforded to private property (Lippmann 45-51). Likewise, Franklin Roosevelt asserted that government non-interference in high business had come to violate the Lockean social contract on which the American government had been founded, as it showed favor to a "small group at the expense of its duty to protect the rights of personal freedom and of private property for all its citizens" (Roosevelt 748).

By the 1930s, few liberals actually advocated the

complete disestablishment of the "centralized economic system" (Roosevelt 749). Despite his rhetorical deference to the traditional Lockean conception of the state as protector of property, Roosevelt did not regard land and decentralized business as the only "genuine private property" worthy of legal protection (Lippmann 51). Many had hoped that a mechanized economy could raise the national standard of living, release Americans from the toil of manual labor, and make luxury accessible to all. Industrialization was, therefore, not inherently antithetical to property interests. The threat to American liberty posed by the new economic order arose from its tendency to reduce masses of laborers to complete dependence on industrial oligarchs, who, if left uncontrolled, could easily subject their dependents to "starvation and penury" (Roosevelt 749).

To Roosevelt, little distinguished the economic dependency of the individual from his political subjugation by a despotic government. Similarly, Dewey understood economic security as a necessary prerequisite to the development of personal competency. According to Dewey, "the basis of life" must first be secure before an individual can realize his "capacities" and contribute to the cultural enrichment of society (Dewey 323). In Dewey's opinion, such self-realization functioned as the necessary "key" to happiness (Dewey 360). Because the preservation of competency constituted the function of a government that aspired to the promotion of happiness, both Roosevelt and Dewey concurred that, in order to protect competency, the state must secure its citizens from severe destitution and ensure the fulfillment of their basic material welfare.

In referencetoprivateproperty, modern liberalism espouses convictions contrary to both classical Lockean liberalism and the Burkian conservatism articulated by Russell Kirk. Government has an end beyond the preservation of property interests. It must defend the capacity of the individual to think and act freely, to determine his own fortune and manner of contribution to society. "Happiness," as President Franklin Roosevelt stated, "lies in the joy of achievement and the thrill of creative effort" (Roosevelt). Freedom of the individual is not necessarily linked to government non-interference in the domain of property, as Kirk would contend. Because economic institutions risk devolving into Leviathans as much as states, conservatism sacrifices the sanctity of individual autonomy to the inviolability of property rights.

This modern liberalism rejects the social contract articulated by Locke, in which people voluntarily enter into a state of society only to ensure the preservation of property (Locke 355-360). Government is instituted with the aim of securing each individual's right to self-actualization and personal competency. As a result, it is the responsibility of government to secure for the governed the basic economic and social protections necessary to pursue happiness. The liberal's social contract is, therefore, the evident heir of the social contract proclaimed in the Declaration of Independence. All men, though unequal in most degrees, retain an equal and inalienable entitlement to life, liberty, and happiness. Government is instituted for the protection of such rights, and consequently, any polity destructive to them can claim no legitimate sovereignty over the people. Insofar as the economic order threatens to subjugate the greater populace to a coercive and despotic penury, it imposes upon their rights to pursue happiness. It remains the responsibility of government to protect its people against such tyrannical property interests, and thus, the government may justly overstep its traditional non-interference in private business. Failure to do so would amount to nothing less than a breach of the social contract that would invalidate the government's claim to hold sovereign authority over the governed.

The great purpose of government, according to Barack Obama, lies in its ability to help citizens live with dignity (Obama 361). The government must actively promote happiness, and as a consequence, the liberal favors the implantation of programs that assure a basic level of social welfare for all. Conservatives, such as William Buckley, argued that "freedom goes hand in hand with a state of political decentralization" (Buckley 197). True to the "conservative mind" of Edmund Burke, freedom requires the preservation of private property and traditional social hierarchies. Any centralization of government that threatened these structures would constitute a repressive Leviathan (Kirk 8). Yet how can an individual exercise the "organized intelligence" Dewey considered vital to society if he does not possess such "bases of life" as food, shelter, and education (Dewey 323-330)?

In an echo of Maslow's hierarchy of needs, the liberal believes that the attainment of happiness, social intelligence, and self-actualization presuppose the fulfillment of certain basic necessities. Since the

New Deal, American liberalism has distinguished itself from conservatism by its support of welfare programs. Some historians, such as Louis Hartz, have argued that New Deal liberals, in their departure from the classical liberalism of Locke, came to resemble the Marxists of Europe (Hartz 266). With no serious socialist threat in America, Franklin Roosevelt could challenge traditional property interests without ceding the legitimacy of America's Lockean republic. Though Roosevelt may have proven more antagonistic to property interests than European liberals, a commitment to neither Lockean property rights nor Marxist collectivism motivated his support for New Deal welfare programs. Rather, he remained committed to the Jeffersonian belief that government existed to protect the liberty and happiness of all of its citizens (Roosevelt 748, 755). All citizens possessed the fundamental right to "make a comfortable living" (Roosevelt 754). As a consequence, Roosevelt understood the New Deal to be a new set of terms for the old social contract of 1776. It represented the course of action necessary to prevent "a rising tide of misery" from devouring the Declaration's vision of a state dedicated to the "never-ending seeking for better things" for all (Roosevelt 744).

The modern liberal remains committed to Roosevelt's vision of a government that actively promotes such "rights of personal competency" as free thought, free speech and a comfortable livelihood free from "famine or dearth" (Roosevelt 744). To secure these rights and foster a society in which individuals can achieve the "realization of their capacities," the liberal has come to see certain social services, such as education, as a fundamental right of the populace (Dewey 323). Barry Goldwater regarded federal aid to education initiatives as illegal. According to Goldwater, the federal government possessed neither the "right" nor the "duty" to intervene in education, as the Constitution does not explicitly delegate authority over education to the national government (Goldwater 72). In contrast, Barack Obama has proposed the extension of federal education programs to encompass government-subsidized daycare (Obama 342). If the Constitution does not enumerate the right of the government to regulate education, it certainly does not empower it to fund early-childhood programs, such as daycare. Yet the stark division between Goldwater and Obama on the question of education underscores the root ideological distinctions between the modern

American liberal and his conservative counterpart.

Conservatives adhere strictly to Lockean property concerns. Because the conservative understands property as intimately tied to personal freedom, federal education systems endanger liberty by wrongly appropriating money that should be spent voluntarily (Goldwater 76-77). On the contrary, John Dewey concluded that the work of the liberal “is first of all education” because “such happiness as life is capable of” derives from the discernment of meaning from the experience of “genuine education” (Dewey). Without a sufficient education, an individual cannot fully realize the extent of his capacity to achieve self-actualization or to effect societal change. Thus, to not pursue universal, high quality education only condemns America’s poor and middle-classes to a life of partially-fulfilled competency. Though Goldwater would argue that it is neither the right nor duty of government to provide its citizens with education, as each state must regulate the adequacy of its own educational programs, the liberal believes that the federal government possesses both the authority and the responsibility to secure the “personal competency” (and thereby “secure” the liberty and happiness) of all its citizens.

In his discussion of constitutional construction, Barack Obama stated that the Constitution has succeeded in defending America against tyranny because it represented a repudiation of absolute truth and an affirmation of the fallibility of all ideas and ideologies (Obama 93). Such a statement, no matter its rhetorical flourish, is simply untrue. As Abraham Lincoln affirmed on the blood stained fields of Gettysburg, our nation was founded upon ideology. It was conceived in liberty and dedicated to the explicit proposition that all men are created equal. The founders’ faith in the self-evident equality of man and the tyranny of monarchy certainly served to repudiate the socio-political structures of monarchy and aristocratic oligarchy. Yet, the social contract expounded by the Declaration of Independence also rejected one of the fundamental premises of Lockean philosophy. It affirmed that governments are instituted among men to protect the inalienable rights of life, liberty, and the pursuit of happiness, not merely to ensure the protection of private property.

Those Americans who persist in formulating a government focused primarily on interests of private property are, in effect, violating the terms of

America’s social contract. America was not fashioned as a socialist state, and as a consequence, the modern American liberal concedes the importance in protecting private property, so long as such property interests do not prohibit other Americans from living freely and pursuing happiness. A conservative critic might counter that the subjective nature of happiness renders it a useless tool in guiding government policy and that Marxists and socialists have justified the elimination of private property on the grounds of promoting societal happiness. The conservative may proceed to conclude that private property cannot be protected at all if it is not protected absolutely. In response, the liberal must reply that much like governments, long established precedents regarding property “must not be changed for light and transient causes.”

All men are created equally entitled to pursue happiness. Thus, concerns of private property become tyrannous, not when they introduce economic stratification, but when they subjugate the average American so fully to the economic elite that self-actualization and self-determination become infeasible. America must protect the “personal ambitions” of each individual, but in so doing, it must not allow a desire by the prosperous to “add more to the abundance” to obscure the government’s moral and contractual duty to provide “enough for those who have little” (Roosevelt). As a nation conceived in liberty and dedicated to equality, it remains the responsibility of our government to recognize each individual as equally valuable and equally entitled to pursue happiness with the same degree of liberty as his peers.

The modern conservative movement has affirmed many ideologies but has lost sight of the true purpose of the American government, offered of the people’s representatives, for the benefit of the American people, and contractually accepted by the people themselves. Many liberals have also lost sight of this fundamental American ideology. However, even within the guise of the pragmatic and anti-ideological, the American liberal distinguishes himself by an unwavering commitment to America’s most fundamental promise:

*We hold these truths to be self-evident, that all men are created equal, that they are endowed by their Creator with certain inalienable rights, that among these are Life, Liberty and the pursuit of Happiness.*

This optimistic faith, this simple but

revolutionary premise that government can promote a “morally better world” of “ever-richer life” constitutes the true genius of America (Roosevelt; Obama). Thus, despite his commitment to a pragmatic politics of “what works” even Barack Obama can concede that “If the people cannot trust their government to do the job for which it exists—to protect them and to promote their common welfare—all else is lost (Obama).

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# The Role of Butch/Femme Relationships in Transgender Activism: A Codependent Mutualism

Atticus Lee<sup>1</sup>

"If I wanted a man, I'd be with a real one."

"I'm not with a fake man; I'm with a real butch."

Throughout decades of queer feminist consciousness, butch lesbianism has been the subject of much heated debate and breaking points among progressive women. This troubling tension and hostility has resulted in the relocation of butch-femme romantic partnerships to transgender spaces; a distinct mutualism has developed between the butch-femme dynamic and the transgender community. This symbiosis redefines both the transgender and butch-femme experience to promote better understanding between groups of marginalized people and more opportunities for solidarity and activism.

## The Butch Identity in Transgender Space

Butch lesbians play a substantial role in transgender communities and this involvement has led to the formation of a channel between transgender and lesbian spheres of discourse and activism. Over time, the butch identity has negotiated a new delineation on the gender spectrum and now embodies a new breed of masculinity for those who can comprehend its delicate balance between survival and self-expression.

The butch gender identity has declared independence from the implications of biological maleness, both in behavior and self-perception. As feminist scholar Gayle Rubin suggests, "the coexistence of masculine traits with a female anatomy is a fundamental characteristic of 'butch' and is a highly charged, eroticized, and consequential lesbian signal (Rubin 470)."

By assuming a butch lesbian is a woman pretending to be a man, we feed into society's gender norms that dictate all gay men to be effeminate queens and heterosexual women to be quiet-rinse dishwashers. Rather than embody the social implications attached with a masculine-presenting physicality, butches hug the line between femininity and masculinity and challenge the very existence of this binary. As a

femme lesbian once verbalized, "[butches] destroy the whole notion of two genders with [their] alchemy, blending the best characteristics of both into a smoking hot potion uniquely [their] own (Feinberg 98)."

The presence of the butch lesbian is also appropriate in transgender space because as masculine-presenting queer women, butches enter transgender space pre-equipped with the knowledge of heteronormative and sexist oppression and offer an incredible degree of sensitivity and insight.

## Implications of the Transitioning Butch Lesbian

Ever since the advent of second-wave feminism, butch lesbians have been transitioning to FTMs (female-to-male transgender) in increasing numbers, a factor that explains and necessitates their growing role in the transgender community. "FTMs comprise only a fraction of the transsexual population, but their numbers are growing and awareness of their presence is increasing (Rubin 473)." As a recent article in *The New York Times* also suggests, "while still a rarity, young women who become men in college, also known as transmen or transmales, have grown in number over the last 10 years." According to research at the Stonewall Center at University of Mass., Amherst, transsexuals who wished to transition historically did so in middle age, but today the majority of physical gender reassignments occur in adolescence or early adulthood. The National Center for Transgender Equality estimates that "between a quarter of a percent and 1 percent of the U.S. population is transgender — up to three million Americans (Quart)." Additionally, "many FTMs live as butches before adopting transsexual or male identities, [and] boundaries between the categories of butch and transsexual are permeable (Rubin 473)."

In a sense, this is a sign of times that have shifted to allow more acceptance of transgender individuals, in the same way that sexual minorities have gained visibility and assimilated into parts of mainstream culture. Stone butches, masculine women who engage in sexual acts only to give pleasure to their partners, often transition into men; most then become feminist men with extraordinary insight from female socialization and experience in a patriarchal world. This

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trend is also paradoxical—as butch lesbians have become increasingly ostracized by lesbian feminist rhetoric for their masculine presentation, they have increasingly transitioned into male bodies and identifications. Their departure from the lesbian mainstream is often not a willing exit, but one that grants them clemency from the social persecution associated with gender transgression. As one butch-turned-FTM individual chronicles, “they drove us out, made us feel ashamed of how we looked...they said we were male chauvinist pigs, the enemy. It was women’s hearts they broke. We were not hard to send away, we went quietly (Feinberg 11).”

Indeed, academics attribute these increasing transitions to the drastic rejection of masculine-presenting women by lesbian communities ever since the ‘70s. Despite coexistence under the “queer umbrella,” lesbian feminists have been historically intolerant of transsexuals, treating MTFs as “menacing intruders” and FTMs as “treasonous deserters.” Feminists also perpetuated derisive stereotypes of gender-variant individuals as “unhealthy, deluded, self-hating, enslaved to patriarchal gender roles, antifeminist, antiwoman, and self-mutilating (Rubin 474).” Due to this vehement disapproval inflicted by their own communities, butches have found the necessity to leave and find their own space, taking with them their femme life partners. Second-wave feminism especially spurned butch and femme women, accusing them of conforming to socially-prescribed gender roles leftover from a chauvinistic era. The lesbian community has been known to succumb to bigotry, exclusion, and renunciation when confronted with perceived threats to the queer-women-centered lesbian infrastructure. In 1991, The Michigan Womyn’s Music Festival was fiercely controversial at the national lesbian conference, which banned all but “womyn-born-womyn” from the events. Second-wave lesbian feminism has not been compassionate to masculine women, justifying discriminatory policies “so blatantly on recycled biological determinism (Rubin 475).”

The phenomenon of increased sex reassignments further necessitates the presence of butch-femme dynamics within the transgender community. A woman respected and loved as a butch lesbian may suddenly become despised when she embarks on a journey to change her physical sex. This trend also has multi-faceted implications - the shift in identity seems to not only confirm lesbian feminism’s accusation that masculine-presenting women secretly want to be men

in a quest to possess male privilege, but also invariably forces their lesbian partners to reevaluate their own sexualities and roles in the lesbian community.

### **Implications of the Genderqueer Butch**

In relation to the gender spectrum, butches may also identify as genderqueer, thus propelling themselves and their partners to the newest frontier of the transgender movement. The genderqueer identity self-defines as anything from a bi-gendered (existing as both genders simultaneously) to a genderless identity (one who exists outside the constructs of gender itself), and is united in the rejection of a traditional gender binary. The genderqueer movement embodies the concept of gender fluidity, explores the transience of identity, and is thus an appropriate branch of transgender rights. Butch alignment with genderqueer represents new solidarity in transgender activism and demonstrates the inaccuracy of assuming that someone with a masculine presentation must be trying to emulate biological men. Butch lesbians debunk the gender binary with their mere existence; they embody masculine gender presentations without possessing male privilege or participating in the dominant patriarchy.

Butch lesbians are increasingly identifying as genderqueer, although the current lack of a cohesive movement interferes with demographic projections. Many individuals who identify as “trans” today seek not simply to “change their sex but to create an identity outside or between established genders — they may refuse to use any gender pronouns or take a gender-neutral name but never modify their bodies chemically or surgically (Quart).” The trans-community welcomes these individuals, though they self-identify as bi-gendered, gender nonconforming or genderqueer rather than gender-variant or FTM.

Part of their aversion to using labels is generational — “[some queer women] see themselves as genderqueer rather than gay. For them, sexual orientation is fluid. Like some of their peers, [they] want to be — and sometimes imagine they already are — part of the first generation to transcend gender (Quart).” In an interview, butch-to-FTM Rey remarked, “my identity is fluid; it may evolve and fluctuate...my preference is not to use gender pronouns (Quart).”

The implications that result from the genderqueer butch woman include the creation of novel identities of their partners to accommodate the radical and subversive

notion of genderqueer. For one, the self-identification of a butch as genderqueer fuels the need for words like pansexual, omnisexual (as referenced by the NYT article “When Girls Will be Boys), polysexual, or multisexual that affirm the existence of more than two genders and guide hir femme partner into a complementary sexual identity. “The partners of FTMS do not necessarily become bisexual or heterosexual because a lover decides on a sex change, although some do eventually renegotiate their own identities (Rubin 476).” In existing outside the sphere of gender and debunking the binary system, genderqueer butches also inherently challenge the gender expectations of the transgender individual. Along these lines, the existence of genderqueer also redefines the transgender experience. No longer strictly about the journey from one side of the spectrum to another, transgender identity will never be quite the same, and neither should our perceptions of its domain.

### **Salubrious Mutualism of Butch-Femme and Transgender Spheres**

The commensalism between butch-femme partnership and transgender identity has been a mutually necessary and adaptive alliance of the queer movement. This is especially accurate in the context of butch lesbian survival and evasion from physical and social harm.

In recent decades of lesbian feminism, butch/femmerelationshipshavebeendemonizedasperpetuating mainstream heteronormativity and catering to society’s prescription of gender performance. Butch women especially have been condemned in lesbian communities for looking like “men” and changing their identity to gain male privilege, and have been consistently painted as traitors and malevolent males infiltrating women’s space. This rejection by mainstream society as well as post-progressive lesbian feminism created the need to secure butch/femme-affirming space and places where butch identity is embraced and not shunned; they found both in the transgender community. As Feinberg’s butch protagonist recalls in the memory of hir femme lover’s face when ze was arrested, “in her eyes I had seen the pain of being overpowered and helpless - the way I felt almost everyday of my life...We really were in this life together. We might not have the words, but we both knew exactly what we were choking on (Feinberg 137).”

On the other hand, the transgender identity has been reconstructed by butch-femme experiences and instances of intimate as well as politically-charged coalitions. In turn, butches and femmes seek transgender space for safe haven – resulting in the comfortable mesh of two overlapping and subversive worlds. The masculine-presenting woman has found compassion and empathy within transgender space where previously ze had only the support and guidance of hir life partner and the elusive, underground butch subculture.

These examples of the mutualism between the butch-femme partnership and the transgender movement establish the benefit and necessity of this coalition. As one femme lesbian described, “Butches are a kind of female we never knew existed! They represent a woven dichotomy of the vast intimacy in a lesbian relationship while offering masculinity, tough exteriors and confidence (Faderman 173).” The butch lesbian embodies an amalgam of tough exteriors and vulnerable interiors that is only revealed for hir partner - the rough exterior that hides a tender, warm, loving human being; ze is a curious blend of contradictions: male/female, strong/tender, playful/serious, soft/hard, confident/humble, protective/in need of protection. These instances refute the common misconception that butch/femme relationships exist in mimicry of heterosexual gender roles, and question this premise to reveal the gender and sexual-identity assumptions that are made with this assertion. As Jan Brown writes about the butch-to-FTM transition, “we become male, but under our own terms, our own rules. We define the maleness. We invent the men we become (419).”

Butch lesbians possess exceptional awareness of heteronormative and sexist oppression that result from experiencing female socialization for entire lifetimes before making the decision to physically transgress gender. From this profound and often painful understanding, butches are predisposed to offer astounding amounts of respect to their partners as fellow women and members of a marginalized sexual population that makes them inherently stand apart from men. As one high femme remarked in Lillian Faderman’s chronicle of American lesbian literature, “[butches/FTMs] can see right into you and know what you want without you having to scream at the top of your lungs to get the point across to them (Faderman 65).”

Additionally, butch lesbians also represent a source of strength, resilience, and inspiration simply

for surviving in a world that subjects them to constant harassment, humiliation, cold stares, and rejection – and still fighting for space to exist. Butch masculinity embodies the sheer courage it takes to stay true to oneself where that appearance can warrant arrest, rape, physical assault, healthcare denial and negligence, state and legislative abuse and neglect, and job termination. As a femme lesbian character expresses in Feinberg’s novel,

“You walk a difficult path with powerful dignity. Mistreated and misunderstood by many, you refuse to be anything other than authentically yourselves. Exuding capability and a bold mesmerizing masculinity, you charge the air with that special aura that only butches and stone butches have, the one that makes femmes twitch as they sense you across a room. Without you many femmes might never come into the knowledge of their own selves, might never know how special they are as well (Feinberg 89).”

The transgender movement cannot help but admire the transcendental way that butches and FTMs have experienced so much by living in a world where they brave prejudice for transgressing gender norms, but draw strength from the pain and become unafraid to be truly themselves.

### **Redefining the Transgender Experience**

The presence of butch/femme partnerships has vastly redefined the parameters of transgender identity from social discourse to sexual practice. The overlap between butch and FTM identity has also aided the transport of femme presence into transgender communities, reinforcing the mutual codependence between gender nonconformity and the butch-femme dynamic. The most universal instances involve femme support for her partner’s unique experience and needs within the umbrella term of transgender. Femmes provide intimate/sexual validation of butch partner’s gender identity, sexual orientation, and often also their sexual practices. In the case of the stone butch, hir femme partner’s sexual function even revolves around the femme’s ability to “melt the stone” and coax the desires nestled deep within butch masculinity to surface. This example of the femme’s validation of stone butch sexuality reinforces the intimate and multi-faceted support femmes provide at every step of the journey and put them in the rare position to provide objective commentary and transcripts of the

transgender butch experience. Femme partners have become the main active support figures apart from other transgender individuals in the community, since in most cases butch or FTM lesbians face familial condemnation and a degree of social rejection after coming out. Femmes are capable of offering insightful and important perspectives from understanding and interacting with their partners in ways the outside world never experiences – from the horrors of being denied proper medical attention in an ER at 4 a.m. to the thrill of injecting the first syringe of testosterone into her partner’s buttocks. The femme partners of FTM/genderqueer butch lesbians are instrumental in documenting the experiences of transgender individuals, and this ties in with the struggle to gain queer and transgender visibility. As Quart documents, “I’ve saved 20 voice mails of your voice changing over the last four months.” He looked at her adoringly as they ate French fries in sync: Melissa was not only his girlfriend but also the historian of his identity (Quart).”

For FTM or genderqueer butches who may be attracted to women on the feminine-presenting end of the spectrum, femme lesbians also represent a rare population of potential friends and romantic partners. The loneliness that accompanies the transgender butch experience is well documented, and femme partners also offer unique and compassionate perspectives about the process of physical transition that are invaluable to the progression of the movement. As Feinberg chronicles through hir protagonist, “I don’t know what the fuck I am. I just don’t want to be different anymore. There’s no place to hide. I just want everything to stop hurting so much (Feinberg 159).” Physical, financial, and practical support aside, femme partners of transitioning FTMs offered the solace of friendship and emotional validation at each stressful change and turn of events. As *Stone Butch Blues*’ butch-turned-FTM protagonist said, “as the world beat the stuffing out of us, [our femmes] tried in every way to protect and nurture our tenderness (Feinberg 46).”

Bisexual femmes in particular, as opposed to lesbian separatists who denounce all trace of “maleness” or even the appearance of it on a full-pledged member of the lesbian community, understandably exhibit more tolerance for the male-identification of their partner, although this is certainly not exclusively the case. As the protagonist of *Stone Butch Blues* remarked, “[my femme] held me inside her warmth... without words I

told her everything she felt... without saying anything she let me know she understood (Feinberg 70)."

"Later that night I woke up and found myself alone in bed. You were drinking at the kitchen table, head in your hands. You were crying. I took you firmly in my arms and held you, and you struggled and hit my chest because the enemy wasn't there to fight. Moments later, you recalled the bruises on my chest and cried even harder, sobbing, "it's my fault, I couldn't stop them. In that one moment I knew you really did understand how I felt in life. Choking on anger, feeling so powerless, unable to protect myself or those I loved most, yet fighting back again and again, unwilling to give up (Feinberg 10)."

In both these instances, the unity in misery and frustration demonstrates the role of the femme lesbian in transfiguring the transgender butch experience.

In response to the nurture and emotional support of femme partners, butch women in turn validate the femme identity in queer women circles (especially second-wave feminism) and combat discrimination against femme lesbians for their traditionally feminine-presenting physicality and allegedly buying into the system of gender roles. In explaining the comfort that butch and femme lesbians are able to find in each other's company, one femme lesbian expressed, "We just fit, you know? She kissed me again. 'You're the only women in the world who hurt almost the same way I do, you know? You're the tenderest lovers in the world (Feinberg 108)." The well-documented ostracism that masculine-presenting women have endured from lesbian feminist communities is not exclusive to those with crew cuts and BVDs; femme lesbians also brave the harsh criticisms from lesbian subculture that condemn them for being "stereotypical" women. In Lillian Faderman's collection of lesbian herstories from twentieth-century America, one femme lesbian expressed gratitude towards her butch partner for "how you make me feel welcome and at home in the queer community, instead of being condescended to by others for 'looking straight' (Faderman 134)."

Butches and femmes also face common oppression together from society, and in their love are building intimate and politically important coalitions for both the transgender as well as the lesbian movement. Butch and femme relationships were "brilliantly adapted for building a minority-sexual culture out of the tools, materials, and debris of a dominant sexual system (Rubin 477)."

In the momentous and socially transgressive journey from butch lesbian to FTM male and everywhere in between, the transgender butch experience has claimed its rightful space within the transgender identity, hand in hand with the priceless contributions of its femme partner's experiences. In this fortuitous setup, butch-femme dynamics have invariably diversified the FTM identity and provided much-needed commensalism between two marginalized and condemned groups of gender outlaws. With the recent influx of butch and genderqueer lesbians and their femme and pansexual/omnisexual/polysexual partners into the transgender community, both parties have been undeniably regenerated and remodeled into greater self and reciprocal understanding and better empowered to stand in solidarity against the common foe of the sexist, heteronormative patriarchy. With the intimacy of butch-femme love and trust transposed onto the political coalition between butch-femme partnerships and the transgender experience, this new departure from post-modern lesbian feminism offers a refreshing reminder of the unity of the oppressed and the universal human capacity for endurance as well as compassion.

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## The Inn, the Castle, and Spaceman Spiff

Eric Messinger<sup>1</sup>

In the novel *Don Quixote* the main character looks at what is really an inn, and sees a magnificent castle. In the comic strip *Calvin & Hobbes*, Calvin is sent to detention for not paying attention, and sees the events as the capture of “Spaceman Spiff” by evil aliens. These two comedic episodes are, in their depiction, essentially equivalent, and both works repeat countless variations on this same episodic formula. The technique is central to both works, and to their charm and quality. The works’ reliance upon it carries with it a number of prominent textual characteristics. The end result of employing the technique again and again, the development of two rich but unbridgeable spheres of realism and imagination, poses the risk of an excessively static world within the work, and both Miguel Cervantes and Bill Watterson work against this difficulty in the same way. Through their use of ambiguity—the shielding of certain truths from the over-determining framework of their realism—the two authors avoid this danger and are able to represent something they wish for in the world but cannot openly introduce.

During his first sally, the valiant Don Quixote grows tired of riding and spies an inn in the distance. Miguel Cervantes writes that

since everything our adventurer thought, saw, or imagined seemed to happen according to what he had read, as soon as he saw the inn it appeared to him to be a castle complete with four towers and spires of gleaming silver, not to mention a drawbridge and deep moat and all the other details depicted on such castles. He rode toward the inn that he thought was a castle.<sup>1</sup>

Cervantes here lays out the rules of the game that he plays for the rest of this episode. There is a real inn, and Don Quixote sees it as a castle. The reader encounters both perspectives, and Cervantes carefully delineates between them. Inhabiting them both simultaneously is impossible; it is either an inn or a castle. The reader considers what Don Quixote is seeing, and notes its major features, and having noted them moves back to considering the “real” scene, with the inn.

In *Calvin & Hobbes*, a late twentieth-century comic strip by Bill Watterson, the same technique is at work. In the strip’s first month in print, Calvin gets in trouble with his teacher, Mrs. Wormwood.<sup>2</sup> In the first panel, Calvin stares into the distance while she teacher announces she will bring him to the principal’s office. For the second and third panels, the perspective switches to a depiction of the “valiant Spaceman Spiff,” being led by an alien guard before a bespectacled alien leader sitting behind a desk. Spaceman Spiff then “springs into action.” For these two panels, due to the correspondences with the information at hand, the reader understands the scenes to be Calvin’s imaginative riff on what is really happening. In the last panel, depicted within reality, the principal and Mrs. Wormwood look on at Calvin, and the principal asks “why is he eating his hall pass?” Watterson establishes reality and then lets the reader know the way Calvin envisions his experience. The indication of a switch in perspective is now no longer linguistic, as in *Don Quixote*, but visual. To show what Calvin is seeing, Watterson draws the panel from his perspective. Accounting for the differences in mediums, the shifts have an equivalent vocabulary.

These two early episodes are paradigms of a technique that occurs throughout both works, though with many variations. All of these uses of the technique play the same game. There is a perspective that the reader recognizes to be what the hero sees or envisions, due to linguistic and/or visual indicators, and there is reality. The author lets the reader know what is really happening and what the hero makes of the experience. The intercutting between the real and the fantastic creates an enjoyable tension in what the reaction or consequences will be due to this disconnect in perspectives.

Beyond their equivalent uses of the technique, *Don Quixote* and *Calvin & Hobbes* share a number of features. These all appear related to the method they share, and therefore suggests the extent to which its use carries with it—or is simply the most notable part of—a wide set of textual features, all of which contribute to a depiction of reality that is both rich and static. The strength of this static reality receives a confirmation in the way in which the authors work against the worlds they create in order to provide a spark of magic central to their sentiments. The use of ambiguity in Watterson’s

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expansion of reality through the unclear nature of Hobbes' existence, and Cervantes' reconciliation of realism with Spanish reality through the bafflingly rapid printing of the first volume within the world of the second, indicate the extent to which pairing perspectives has a determining effect upon a work that extends even to the method of circumventing its static framework.

Cervantes and Watterson both depict the visions of their heroes in a richly realized and legitimate form. In *Mimesis*, Erich Auerbach describes a passage where Don Quixote addresses the ugly peasant who he thinks is his lady Dulcinea, and declares that "in the middle of a parody against the knightly ideology of love we find one of the most beautiful prose passages which the late form of the tradition of courtly love produced."<sup>3</sup> Cervantes does not sabotage the expressions of his hero by displaying his chivalric visions and his actions relating to them in a deprecated or inferior manner. He condemns the viewpoint, but represents it in good faith. Watterson matches Cervantes in this regard, and in some ways outdoes him. The enthusiasm he brings to Calvin's visions, no matter how ridiculous, never flags. In a late strip, Calvin waits in line for a drink of water behind Moe the bully, and makes the two of them dinosaurs in a prehistoric scene.<sup>4</sup> Watterson draws an allosaur and an ultrasaur in an anatomically realistic style, even with Calvin's narration being what it is: "the big, stupid ultrasaur takes a long drink...a *very* long drink..." The narration is preposterous, but he carefully renders every detail of the dinosaurs. Cervantes and Watterson both acknowledge that the visions of their heroes are ridiculous, but choose not to sabotage their expressions in service of this view. The result is to sustain some of the legitimacy of the hero's perspective despite the ceaseless demonstrations that they are imagining. This in turn strengthens the depictions of reality in both works, which assert themselves and triumph against even a richly realized and compelling fantasy.

The episodes within both works also often have a great deal of potential for sadness or tragedy, but their overwhelming tone is comic. This avoids the lasting change to the formula that would be threatened and promised by a tragic tone. The paradigmatic examples in both cases are the violent challenges of Don Quixote, and the beatings that result, and Calvin's wagon or sled rides. These always seem to end with Calvin and Hobbes headed towards some awful fate,<sup>5</sup> or the injurious crash actually depicted.<sup>6</sup> Each provides slapstick humor, in the

manner that harmless violence always has a tendency towards. Yet this would quickly turn into a sickening dread without the established expectation that this will never end *too* badly. Don Quixote always recovers, and Calvin never suffers lasting scars from his various calamities. Within an episode, harm can receive realistic depiction, but the heroes shake off their ill effects, and their conduct is incorrigible; Calvin perceptively notes that "we don't want to learn anything from this."<sup>7</sup> When the works stray from this and present a danger that seems potent, the entire tone shifts. The encounter of Don Quixote and the lions is quite difficult to find funny, at least before the lion backs down from combat, because for once it really does appear as if his madness has led him to a real and fatal danger.<sup>8</sup> Even Sancho notes that this is something unamusing, "compared to which the adventure of the windmills, and that of the waterwheels, and, in short, all the feats he had performed...had been nothing but child's play."<sup>9</sup>

These similar features in the two works create a strong sense of the real and the fantastic, the profound divide between them, and the immutability of this state of affairs. This all furthers Cervantes' most cherished goal. Joan Ramon Resina explains that Cervantes makes it very clear that he is after realism. "In the priest's scrutiny of Don Quixote's library (bk. 1, chap. 6) verisimilitude, or what we call realism, is the touchstone for literary criticism. The books that pass the scrutiny amount to a cultural literacy list for readers of fiction. They also furnish a pretext to outline the features of the genre Cervantes is trying to shape," namely one with a heightened realism.<sup>10</sup> The technique does not allow for permeability between the imagined perspective and the real world. That this rule is inviolable and essential is evident in the fact that *nowhere* in both of these very long texts does something *certainly* happen for a fantastic reason. In any situation where the authors present both perspectives, the imagined perspective never gains the upper hand in credibility.

Therefore, the possibility of enchantment lies only where the narrative does not extend its reach and establish the underlying reality. Cervantes and Watterson reserve this privilege for what is at the height of their sentiments, of such prime importance that they feel the need to work around their technique in order to preserve the possibility of its realization. The two achieve this in an equivalent fashion through the use of ambiguity. Through this, each author extends his



visions for what the world can or should be.

The reality of Hobbes within *Calvin & Hobbes* is fundamentally uncertain. Within the world of the strip, Calvin has a stuffed tiger, who he calls Hobbes. For Calvin, however, the tiger is alive. No one but Calvin ever sees a “real” Hobbes. Watterson tightly and precisely controls this through Hobbes’ appearance, on display in a strip where Calvin finds a missing Hobbes at Susie’s tea party.<sup>11</sup> She stares at Calvin, but he looks behind her to a living Hobbes; in the next panel, Susie can see Hobbes, and he is back to being a stuffed animal. Calvin’s eye-line animates Hobbes behind an unsuspecting Susie. In this sense, where Hobbes is a fantastic element appreciable only to Calvin, Hobbes is similar to Calvin’s numerous other imaginative flights of fancy.

There are two differences, however. First, Hobbes has continuity. The collection of glosses upon reality which Calvin adopts is quite diverse, yet Hobbes is always himself. Hobbes is his friend, distinctively so, and it is possible (and inevitable) to speak of him as a character with a distinctive personality. Second, and far more crucial, the “reality” of Hobbes is not a settled question in the strip. On several occasions, a “real” Hobbes actually makes more sense than a stuffed tiger, given physical laws and other concerns. Hobbes can terrify Calvin by waking up on top of him,<sup>12</sup> attack him unawares,<sup>13</sup> or trick him outright while moving independently.<sup>14</sup> All of these are a difference in kind from Calvin simply playing make-believe, on both a psychological and physical level. Perhaps the oddest instance comes in a strip where Calvin’s dad walks in and finds Calvin tied to a chair, after a living Hobbes ties Calvin up.<sup>15</sup> Calvin’s only explanation is that Hobbes tied him up; that is, after all, what he, and the reader, saw happen. His dad does not believe this is possible and sends him to his room. He does not offer a clear counter-explanation in this instance, yet the only one available is even less helpful: what a living Hobbes would mean, and where a shape-shifting totemic demigod fits into the principles of the world, is not at all clear.

In other words, neither of the explanations *really* satisfy. Because the episodes in question are not always put to the challenge of the paired representations of the two perspectives – a test reality always and everywhere wins in the work – the text’s main verifying tool is useless. Yet this does not unravel the entire work precisely because no consistent (and unsatisfactory)

explanation receives complete confirmation. In this manner Watterson provides a spark of magic to the work, something not entirely explained, yet not decisively fantastic. This loose end in the text adds a great deal of interest and legitimacy to the central relationship and the perspective of the hero. It is line with Watterson’s aspirations for the mundane world he depicts, where reality otherwise continually confounds the free play of a child’s imagination.

Cervantes in *Don Quixote* provides a similarly prominent ambiguity, the incredible publication of the first book within the world of the second. In the first chapters of the second book, Don Quixote and Sancho Panza learn that Spain knows all of their adventures, recorded in *The Ingenious Gentleman Don Quixote of La Mancha* (the title of Cervantes’ first book). The timeframe is entirely too short for this to make any sense, “less than a month” after the return to La Mancha at the end of the first book.<sup>16</sup> Don Quixote, feeling “extremely thoughtful,” “could not persuade himself that such a history existed, for the blood of the enemies he had slain was not yet dry on the blade of his sword and his chivalric exploits were already in print.”<sup>17</sup> He has not slain anyone, of course, but his remarks as to the short timeframe are sound. Odder still, it is clear that the text of the book is entirely accurate to what has happened because it is the exact text of the first book. Sancho remarks that upon hearing of the work, “I crossed myself in fear at how the historian who wrote them could have known about them’.”<sup>18</sup> Cervantes goes out of his way to point out that is a very strange occurrence on both counts. Yet Cervantes does not employ his customary enthusiasm for full explanation, never depicting the publication of the first book or revealing the circumstances of its creation. It occurs somewhere far off and unseen. Don Quixote can only verify a mundane origin for the detestable forged version of the work, in his encounter near the end of the second volume with the printing presses.<sup>19</sup> (Appropriately for Cervantes, combating plagiarism at the time, only the knock-off has a tangible origin). Cervantes furnishes the closest thing to an explanation when he states that Don Quixote “imagined that some wise man, either a friend or an enemy, by the arts of enchantment had printed them.”<sup>20</sup> Don Quixote appears wrong because he tries to force events into the framework of his chivalric worldview, *not* because it is clearly wrong to imagine a fantastic explanation. Laying responsibly on the arts

of enchantment” is not implausible because the whole issue is a muddle.

Any consistent interpretation introduces a problem for the rest of the text. Spain cannot explicitly have a magical printing press for an omniscient observer and remain a realist paradigm for Cervantes, nor can Don Quixote’s chivalric notions receive confirmation. Yet it is even less plausible for Cide Hamete to have trailed along unnoticed and recorded the entirety of the first text, moving heaven and earth to get it into as many Spanish homes as possible. Therefore, by shielding the matter from strict definition, Cervantes achieves both a real excitement and a change in line with his hopes for the world. The wonder of the dissemination of the first book in the second in *Don Quixote* contributes to the sense of a world that is changing in uncertain ways, without toppling the careful framework of reality. Everything old is new again, and the idea of discovery fills Don Quixote and Sancho Panza’s adventures. Cervantes has Spain preemptively recognize the realist paradigm of his hopes, and the results are delightful.

These ambiguities are special cases. Nowhere else in the two texts could readers really find themselves believing in something fantastic occurring. Even the

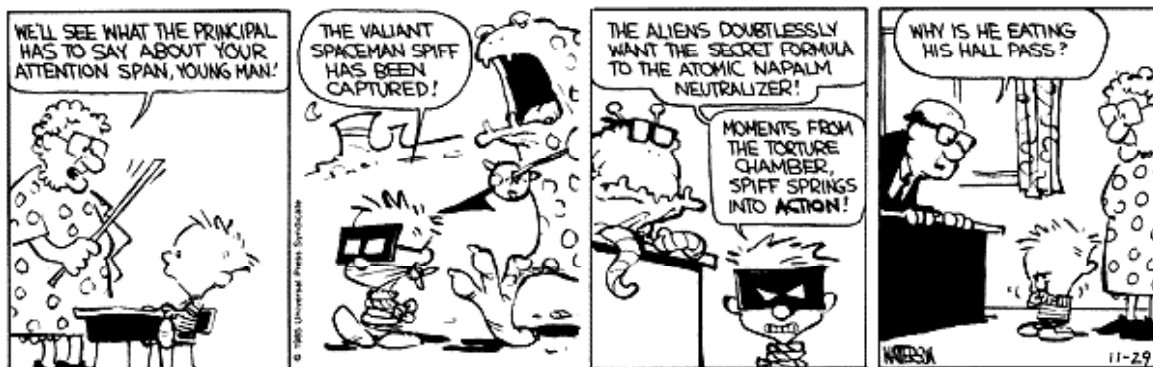
most indulgent interpretations run up against the careful repetitions and delineations Cervantes makes to keep the two spheres separate, or the endless inaccuracy of Calvin’s visions. Whether the ambiguous aspects under our scrutiny happened in a manner in accordance with the principles of reality, however, or due to something genuinely fantastic, does not receive a settled answer. The authors do not provide a definitive explanation, so something occurs that eludes a concrete description. The most stable way of treating the material is, oddly enough, to leave it uncertain. This stable fluctuation, an oscillation between two contradictory and problematic explanations, goes a long way towards instilling the works with a much-needed vibrancy. Reality and the heroes’ visions receive rich depictions, but the spheres are immobile. Ambiguity provides a striving motion that is exciting and engaging without destroying the other benefits of the technique it works around. The texts shelter a hope not fully determined by avoiding the method that has otherwise provided their works a distinctive character. That the ambiguities themselves remain wholly characteristic of their authors I find quite appropriate.

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4. Resina, Joan Ramon. “The Short, Happy Life of the Novel in Spain.” *The Novel*. Ed. Franco Moretti. 2 vols. Oxfordshire, United Kingdom: Princeton University Press, 2006. 291-312.

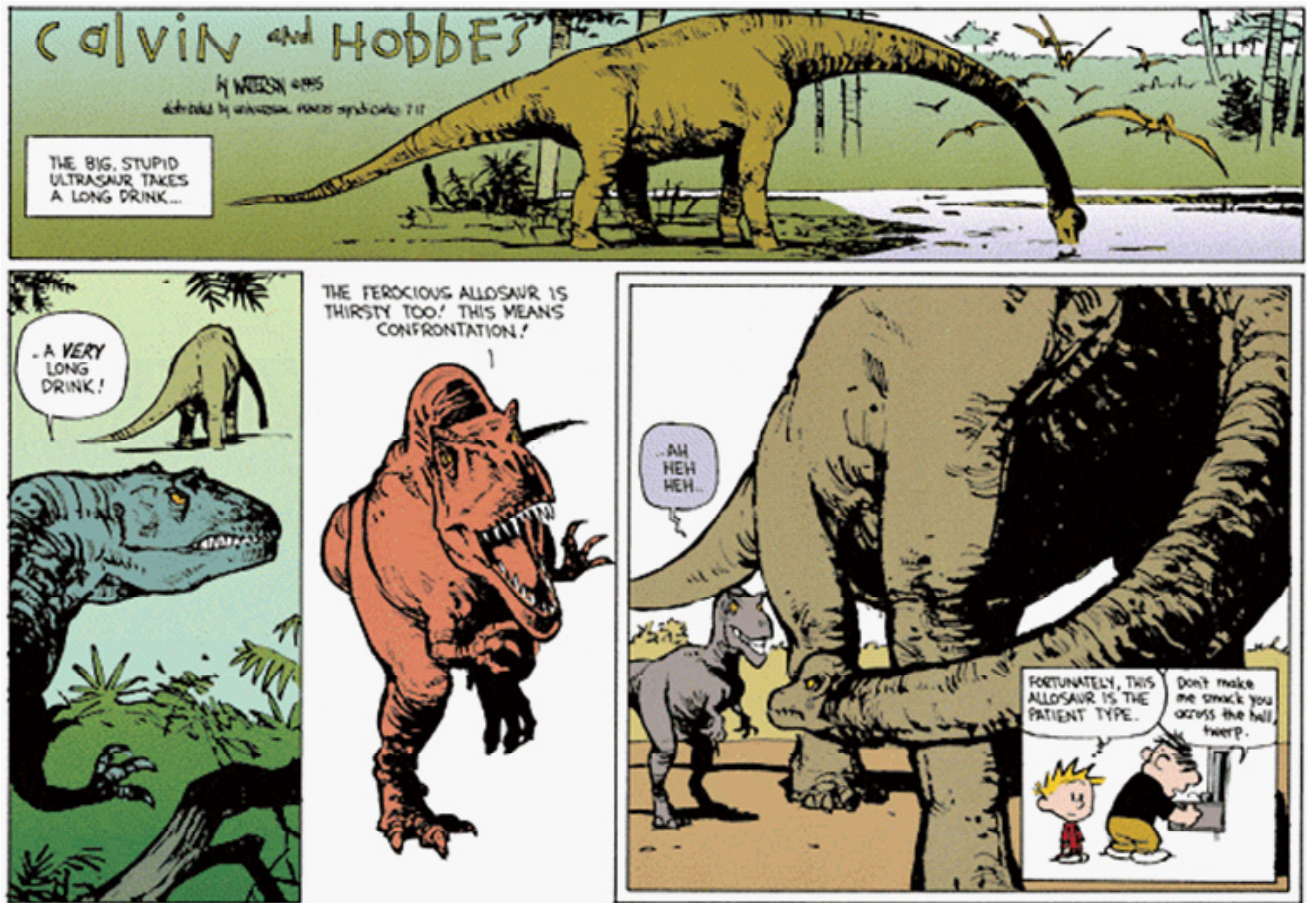
## Notes

1. Cervantes: 26



2. 29 November 1985

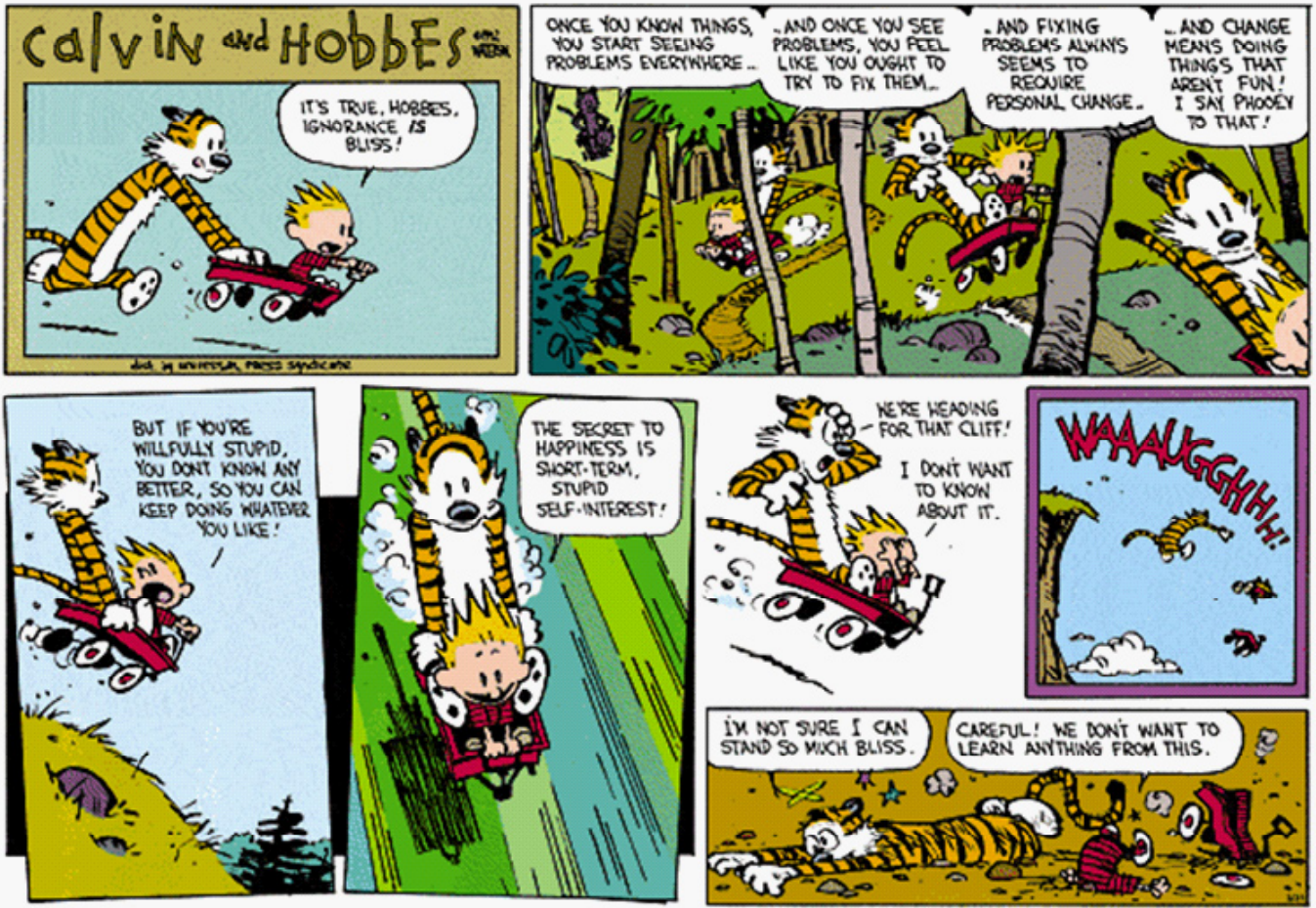
3. Auerbach: 308



4. 1994 July 17



5. 30 November 1985



6. 31 March 1991

- 7. Ibid.
- 8. Cervantes: 558-565
- 9. Cervantes: 562
- 10. Resina: 294



11. 31 May 1986



- 16. Cervantes: 459
- 17. Cervantes: 473
- 18. Cervantes: 472
- 19. Cervantes: 874-875
- 20. Cervantes: 473

12. 16 June 1995



13. 23 January 1993



14. 16 April 1988



15. 5 December 1987



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# Rising from the Fall: Experience and Grace in *Goblin Market* and *Comus*

Zachary Nevin<sup>1</sup>

Stories regarding the Fall of humanity can be found in almost every culture. In general, such stories depict three major characters: the fallen, the tempter, and the savior. There are, however, nearly as many interpretations as to the significance of each character as there are accounts of the story itself. Likewise, there is a well-documented disagreement in classic thought as to whether the Fall was, in fact, a bane to human existence, or perhaps the only path to obtaining Grace. Here, I analyze manifestations of the three characters in Christina Rossetti's *Goblin Market* and John Milton's *Comus* by presenting the two poems in dialogue to illustrate competing interpretations regarding the significance of the Fall.

*A fall it might seem, just as a vicious man sometimes seems degraded below the beasts, but in promise and potency, a rise it really was.*

~Sir Oliver Lodge, "Life and Matter"

Humanity's fall is one of the most commonly reconstructed themes in literature. Even before the incident of the apple in the Garden of Eden, there were ancient myths of Prometheus the Bringer of Fire, Pandora's Box, and Cupid and Psyche, stories wherein the attainment of forbidden knowledge leads to pain and tribulations for mankind. The Biblical Fall especially has been interpreted and reinterpreted, with both members of engrained hierarchies and social agitators twisting it to substantiate their own world views.

One such point of controversy is Eve's acceptance of the apple from Satan. To misogynists and patriarchal cultures, this act is held indicative of women's corruptibility, and is used to justify that they "be regarded as the 'inferior' sex, [not] on the basis of physiology, but according to a mental, divine, otherworldly value judgment" (Monajem). On the other hand, Thomas Aquinas' interpretation of the *Felix Culpa*—the Happy Fall—lends itself to a more gracious interpretation: that Eve's supposed transgression, though causing humanity's estrangement from Eden, allowed for the greater experience of divine Love and salvation through Christ (Aquinas III.1.iii). However,

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Aquinas does not address whether the experience of bastardizations of love—carnal desire, envy, greed, the knowledge and rejection of which may eventually lead on to the discovery of proper Love—are equally beneficial to a person's developing self-awareness. And so, philosophers and authors have argued the merits of such experiences in order to establish at what point knowledge transforms from bane to boon.

In Christina Rossetti's *Goblin Market* and John Milton's *Comus*, two separate cases are proposed. Both depict near-Fall experiences; however, Milton's heroine is rescued before transgressing, while Rossetti's tastes of the forbidden fruit, requiring salvation through another's self-sacrifice. Though both accounts discuss sexuality, only Rossetti's characters engage with it. Subsequently, these stories assume drastically different attitudes towards the theme: *Comus* is a tongue-in-cheek commentary on female chastity while *Goblin Market* is distinctly pro-feminine and delves deeper into the nuanced goods and evils of sexuality.

## **Goblin Market: Sexuality and Salvation**

Rossetti's narrative follows the standard pattern of the Biblical Fall—"temptation, fall, redemption, and restoration" (Christensen). However, she does not simply restate the Biblical account. Rather, Rossetti converts the story into a feminist commentary through the gendering of her characters. Making the primary characters sisters serves two purposes. First, it sidesteps the Biblical hang-up between humanity and divinity—i.e. that only because Christ was the son of God was his sacrifice sufficient to save humanity—reducing the requirements to be a sinner or savior to simply whether one is pure in spirit. Perhaps more important to the feminist perspective, though, is the fact that presenting sisters as both sinner and savior subverts the traditional dichotomy between a female sinner and a male savior, which, at least for Victorian audiences, would have elevated the true message out of the confusion of gender roles and hierarchies of the time (Harrison).

*Goblin Market* is rife with sexual connotations and imagery. At the most superficial interpretation, Rossetti associates the Fall with knowledge of sexual pleasures (Harrison). Laura plays the role of the

fallen woman. Although the origin of this name is unspecified, it is quite possible Rossetti is taking a shot at Petrarch's courtly ideal (Scholl)—the unattainable woman—asserting her own belief that even the purest of women may be tempted. Regardless, that Laura is a “maid” emphasizes the fact that she is “not only virginal but also young” (Christensen). That is to say, even the innocent—or perhaps especially the innocent—are susceptible to temptation. The sexual nature of the temptation is reinforced by the fact that the tempters of maids are goblin men: “Eve is no longer tempted by a [neutered] serpent, but by men, goblins” (Belsey). Thus the conflict between the sexes is established.

Because men are the tempters, however, in order for the feminist message to function, Rossetti realizes she must not let it appear that the men have simply deceived Laura, as Eve was deceived by Satan. To allow Laura to be deceived would portray her as gullible and incompetent, reaffirming the very mindsets feminism seeks to reform. To this end, Rossetti portrays Laura as an active participant in her own Fall: “*She* clipped a precious golden lock” (Rossetti 126, emphasis added). Moreover, as hair is something physically cut from herself, the act highlights that Laura has been defiled, in contrast to Lizzie's later encounter with the goblins.

In addition to attacking gender roles in society, Rossetti's vivid language implicates the reader in her moral questions (Christensen). In fact, the reader does not really have a choice whether or not to engage with the poem: twenty-eight of the first thirty-one lines form a sumptuous description of the goblins' wares, effusive imagery which serves to draw the reader in before the narrative has even begun. And later, whenever the fruit or a scene is described, it recommits the reader, “increasing the momentum of the poem even as the narrative action has halted” (Newman). The imagery is so forceful that some critics have recommended *Goblin Market* as “purely and completely a work of art” (Review 230). And yet, the message cannot be denied.

Lizzie is unmistakably a Christ-figure. She is not prepackaged perfection, however, but must discover her own sexuality before she can rescue her sister. Although Lizzie has intuitive knowledge enough to avoid the goblin fruits (Harrison), she is nonetheless naïve regarding the actual experience they confer, citing Jeanie's death as reason enough to renounce them (Christensen). She does not understand the nature of the pleasures the goblins offer—“Who knows upon

what soil they fed their hungry thirsty roots?” (Rossetti 44-5)—and her naiveté manifests itself as fear: “She thrust a dimpled finger in each ear, shut eyes and ran” (Rossetti 67-8). To counter this fear, the sisters have created a pretense of domesticity. Their daily activities mimic those of a normal household but for one exception: it is devoid of men (Christensen). Thus, Lizzie has created for herself a world in black and white, where domesticity is good because it is familiar, and sexuality is evil simply because it is unknown. But when Laura abandons the domestic sphere and experiences sexuality, her successive conflicting moods of passion and lethargy casts shades of grey on Lizzie's flawed perception, and she must decide between her own innocence and Laura's life.

Ultimately, “Laura's physical deterioration and near-death state make up the impetus that forces Lizzie out of the safety of a childish fantasy—an eternal state of domestic and sororal existence—and into the world” (Christensen). It is very possible Lizzie would have remained forever within her domestic cage were it not for Laura's Fall, but Laura's involvement in Lizzie's transformation is not to be taken as a second salvation. Lizzie is not Fallen, so she does not need to be saved. Just the opposite, her decision to experience sexuality is a statement of self-imposed disillusionment: her fear for her sister has grown to such a point as to outweigh her fear of sexuality, so she “weighed no more better and worse, but put a silver penny in her purse” (Rossetti 322-3). Only now that *she has brought herself* to accept sexuality is Lizzie prepared to assume responsibility for Laura's salvation.

The process by which Laura is saved is crucial to the message of the poem. Reminiscent of the Biblical account of Christ's mortal sacrifice and transcendence to a higher state of being, Lizzie sacrifices her irrational mindset in favor of a true understanding of sexuality (Christensen). However, she does not seek to know sexuality by tasting the fruits as Laura did, but to feel the empowerment gained by rejecting the goblins' wares, frustrating their attempts to defile her, and driving them away. In fact, she garners pleasure from their failure to make her eat (Rossetti 433). Symbolically, she experiences sexuality and gains the knowledge by which to help Laura, but without letting it consume her as it has the others. Or viewed with a feminist slant: she is strong enough to resist men's crude sexual advances, and in so doing is able to explore her own sexuality

while still maintaining control of her body and desires. Armed with this experience, she can now confront Laura.

In the redemption, Rossetti portrays an almost erotic rendition of the Eucharist: “Eat me, drink me, love me; Laura, make much of me: for your sake I have braved the glen and had to do with goblin merchant men” (471-4). Harkening back to the entreaties of the goblins, this invitation to again taste the goblin fruits contrasts the covetous lusts of goblin sexuality with Lizzie’s love-inspired charity. Although it is easy to associate Laura’s subsequent revival with a sense of return to proper sexuality, this is not Rossetti’s complete message. If one recalls that Lizzie, too, was a social outcast before encountering the goblins, the message of social redemption takes on dual significance (Scholl): not only should you moderate your own sexuality, but those who have learned to should protect and empower those who have not. “The message of the poem therefore becomes just as much for the ‘Lizzies’ in Rossetti’s society as the ‘Lauras’” (Scholl).

### **Comus: Experience the Bane, Experience the Boon**

Unlike Rossetti, Milton does not present a strong, independent woman in *Comus*. To the contrary, the Lady is shown to be weak in both body and mind. The plot is initiated when “my brothers, when they saw me wearied out...stepped as they said to the next thicket side to bring me berries, or such cooling fruit” (Milton 182, 185-6). By the Lady’s own admittance, she could not match her brothers’ endurance, and was even to be waited upon. Likewise, intellectually, she lacks the ability to discern Comus’ ploy, being instead immediately taken in by his peasant disguise, even vouching on his behalf that “honest-offered courtesy, [oft] is sooner found in lowly sheds...than in tap’stry halls” (322-4).

She believes she “compensates” for these shortcomings with an insuppressible sense of personal morality:

These thoughts may startle well, but not astound  
The virtuous mind, that ever walks attended  
By a strong siding champion, Conscience.  
O welcome, pure-eyed Faith, white-handed Hope,  
Thou hovering angel girt with golden wings,  
And thou unblemished form of Chastity. (210-215)

And yet, the audience, expecting the motive of the Fall, should realize something is amiss. That the Lady is summarily duped by Comus calls into question her ability to assess reality. Milton extends this doubt to her brothers, who likewise mistakenly assure themselves that her scruples will protect her (366-7). The only character that acknowledges their susceptibility is the Spirit, noting from the very beginning that “their tender age might suffer peril” (40). This statement strikes at the root of the problem: the siblings are young. They, like Laura and Lizzie, have not experienced the world. Moreover, the Lady’s pride in her chastity is but another instance of a young woman refusing to experience sexuality. Unlike in Rossetti’s poem, however, Milton shields his heroine from ever gaining this experience. But in light of the treatment of experience as a boon in *Goblin Market*, this authorial intervention begs the question: has Milton actually spared her or, in denying her the opportunity for experience, hurt her?

Heinrich von Kleist explores this question in his narrative “On the Marionette Theatre,” in which he relates a discussion he had with a dancer on the natural grace of puppets. The dancer explains that “affectation is seen, as you know, when the soul, or moving force, appears at some point other than the centre of gravity of the movement” (Kleist), such as when one dancer presents an apple to another and, “his soul is in fact located (and it is a frightful thing to see) in his elbow” (Kleist). Puppets, on the other hand, “are just what they should be...lifeless, pure pendulums, governed only by the law of gravity” (Kleist). Von Kleist attributes this dichotomy in the grace of movement to consciousness:

As thought grows dimmer and weaker, grace emerges more brilliantly and decisively...

But he continues:

Grace itself returns when knowledge has as it were gone through an infinity. Grace appears most purely in that human form which either has no consciousness or an infinite consciousness. That is, in the puppet or in the god. (Kleist)

To Kleist, the dancer with just enough knowledge to perceive her own flaws and mistakes is significantly worse off than a soulless puppet; this is Laura after her Fall. However, as more and more experiences are



attained, beyond a certain threshold a person will begin to climb again towards grace—a moment exemplified by Lizzie’s “inward laughter” (Rossetti 463). And though she will never obtain the omniscience of godhood, with each incremental increase in knowledge, it would follow that the person will be some degree better off.

In the case of *Comus*, then, it would appear Milton has spared the Lady. As it stands, she is convinced of her morality, and as her brother notes, “she that has that is clad in complete steel” (Milton 421). *Comus*’ suggestive terminology—“Can any mortal mixture of earth’s mold breath such divine enchanting ravishment” (244-5)—leaves no question that his intentions are as sexually-charged as the goblins’. However, unlike Laura, who is already intrigued by the prospects of experience and sexuality before her Fall (Scholl), Milton’s heroine is utterly disinterested in *Comus*’ arguments, complaining “I hate when vice can bolt her arguments, and virtue has no tongue to check her pride” (Milton 760-1). In as far as she is deaf to *Comus*’ ploys, any sense of temptation is lost on the Lady: she is in no real danger of Falling. Thus, were Milton to have continued with the theme as he had initially suggested it, the Lady would not have been so much a fallen woman as a tragic victim of a devilish sprite. So, rather than destroy her moral construct, *deus ex machina* intervenes, the brothers arrive at the critical moment (813), and the Fall is averted.

The implications of this ending are quite convoluted. By removing the element of Free Will that is so crucial to Rossetti’s conception of the Fall, Milton disengages his audience from any sense of responsibility for setting things right. Instead, humanity’s salvation depends fully on Grace from God, who “would send a glist’ring guardian if need were to keep [one’s] life and honor unassailed” (219-20). This presents a paradox in that, though Milton sets the story in anticipation of a Fall, it is as if part way through he decides against the theme, and is quick to place the blame elsewhere. However, because the setup is blatantly present, the story lends itself to another interpretation of the proper use of Free Will that subsequently reinstates humanity’s responsibility towards its own salvation.

The agent of Grace in *Comus* is the Spirit, an omniscient messenger from Heaven “dispatched for [the lady’s] defense and guard” (42). Alexander Pope also discusses such beings, known in mythology as

Sylphs, in his poem *The Rape of the Lock*:

Know further yet; Whoever fair and chaste  
Rejects Mankind, is by some *Sylph* embrac’d:  
For Spirits, freed from mortal Laws, with ease  
Assume what Sexes and what Shapes they please.  
What guards the Purity of melting Maids,  
In Courtly Balls, and Midnight Masquerades,  
Safe from the treach’rous Friend, the daring Spark,  
The Glance by Day, the Whisper in the Dark;  
When kind Occasion prompts their warm Desires,  
When Music softens, and when Dancing fires?  
‘Tis but their *Sylph*, the wise Celestials know,  
Tho’ *Honour* is the Word with Men below. (Pope  
I.67-78)

The key idea, as with *Goblin Market*, is the rejection of physical advances. The difference between Pope, Milton, and Rossetti, however, is that while Pope attributes the rejection to intervention by a divine protector, Milton’s Spirit only rescues the Lady physically—she herself must reject *Comus*’ advances through a series of logical arguments (“Thou canst not touch the freedom of my mind with all they charms although this corporal rind thou hast immanacled” (Milton 663-5))—and Rossetti removes the role of protector altogether, having Lizzie face the goblins alone. For Milton, then, while Grace is the ultimate means of salvation, it is also a process; Grace will only intervene once temptation has been rejected. Humanity’s responsibility, then, is to meet Grace half-way:

Love Virtue, she alone is free;  
She can teach ye how to climb  
Higher than the sphery chime;  
Or if Virtue feeble were,  
Heav’n itself would stoop to her. (Milton 1019-23)

### On Conclusions

*Goblin Market* and *Comus* draw two drastically different conclusions to the story of the Fall. Rossetti portrays the traditional triumvirate of tempter, sinner, and redeemer. Milton, remarkably, manages to omit a true sinner. Rossetti advocates acceptance of sexuality as a necessary experience for social salvation. Milton’s characters live in a bubble of Grace. However, when we recognize that Milton’s characters are in fact ideals rather than true people, we can no longer

take the message in *Comus* at face value. Truly, the bubble burst long ago; humanity was tempted and fell. Experience already permeates our existence, and all we can do now is to resist temptations that would lead to a second, more personal Fall. Thus, it would appear best to follow Rossetti's example: to live for the pursuit of knowledge until we exit from the other side of infinity and once again approach complete Grace.

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# Justifying the Christian Cult of the Maccabean Martyrs

Michael J Petrin<sup>1</sup>

The Maccabean martyrs were Jews killed c. 167 BCE by the Greek king Antiochus IV Epiphanes. The first of the martyrs to die was the elderly scribe Eleazar, who was beaten to death for refusing to eat pork. The rest of the martyrs (seven young brothers and their mother) were then killed for the same offense. Interestingly, these martyrs came to be venerated as Christian martyrs during late antiquity, even though they were Jews who died out of loyalty to the Mosaic Law. In this essay, I examine the earliest known justifications for the Christian cult of the Maccabean martyrs, and I argue that these justifications share a fundamentally similar approach: they argue that the Maccabean martyrs are worthy of Christian veneration by establishing continuity between pre-Incarnation and post-Incarnation history through the figure of Christ. At the same time, however, I explain how the justifications differ, especially with regard to the identity of Christ.

## Body

Of the countless Christian martyr cults that arose during late antiquity, there is perhaps none as intriguing as the cult of the Maccabean martyrs, a group comprising seven brothers, their mother, and the aged Eleazar.<sup>2</sup> The veneration of these martyrs is especially remarkable because they were not professing Christians, but Jews who died more than a century and a half before the birth of Jesus (c. 167 BCE). What is more, the reason for their deaths was that they refused to eat pork, choosing to be killed rather than transgress a prohibition of the Mosaic Law—a prohibition that most late ancient Christians viewed as void.<sup>3</sup> Yet Theophilus of Alexandria, writing to Jerome in 404 CE, was still able to claim that “in the churches of Christ throughout the world, [the Maccabean martyrs] are praised and commended as stronger than the punishments inflicted on them and more ardent than the fire with which they were burned.”<sup>4</sup> Thus, the Christian cult of the Maccabean martyrs must have been at least fairly widespread by the year 404.

There are many questions concerning the Maccabean cult that call for further study.<sup>5</sup> In this essay, however, I pursue the relatively narrow aim of explicating the earliest known justifications for the cult. This is done

through engagement with three early Christian homilies: Gregory of Nazianzus’ *In Machabaeorum laudem* (preached in 362), John Chrysostom’s *De Eleazaro et septem pueris* (preached in 398 or 399), and Augustine of Hippo’s *In solemnitate martyrum Machabaeorum* (preached sometime between 391 and 430).<sup>6</sup> On the basis of these texts, all three of which contain explicit justifications for the Christian cult of the Maccabean martyrs, I argue that Gregory, John, and Augustine share a fundamentally similar approach: they argue that the Maccabean martyrs are worthy of Christian veneration by establishing continuity between pre-Incarnation and post-Incarnation history through the figure of Christ. At the same time, however, I explain how the homilists’ respective justifications differ, especially with regard to the identity of Christ.

## Gregory of Nazianzus

Gregory of Nazianzus begins his homily *In Machabaeorum laudem* by acknowledging that although it is the feast day of the Maccabean martyrs, “not many recognize them because their martyrdom antedates Christ” (§1). Thus, it seems that Gregory was aware of a sizeable number of Christians who did not participate in the Maccabean cult. Yet Gregory views the Maccabeans’ martyrdom as “an act not less generous than that of those who later sacrificed themselves for Christ” (§11), and he argues in favor of the Maccabean cult by establishing continuity between pre-Incarnation and post-Incarnation history through the figure of Christ. Gregory’s unique take on this approach, however, is to emphasize Christ as the Logos, the Divine Reason or Word.<sup>7</sup>

Gregory attempts to establish continuity between pre-Incarnation and post-Incarnation history by claiming that “not one of those who attained perfection before the coming of Christ accomplished his goal without faith in Christ” (§1). He thus incorporates both Old Testament saints and New Testament saints into a continuous historical narrative through the figure of Christ. Gregory explains that this was possible because “although the Logos was later openly proclaimed in his own era, he was made known even before to the pure of mind” (§1). In other words, Christ, as the Logos, was present even in pre-Incarnation history.

Gregory argues that the Logos’ presence in pre-

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Incarnation history “is evident from the large number of persons who achieved honor before his day” (§1). But what does he mean by this? It is not obvious that the Logos had to be present prior to the Incarnation in order for people of that time to achieve honor. After all, was not Achilles honorable? Was not Ajax?<sup>8</sup>

In order to understand Gregory’s claim, we must take into account his reason for esteeming the Maccabean martyrs: “Such noble figures, then, are not to be overlooked because they lived before the time of the cross, but should rather be acclaimed for having lived in accordance with the cross (κατα τον σταυρον)” (§2). Given that Gregory says this immediately after the claim quoted in the previous paragraph, I suggest that “achieving honor,” as Gregory uses the phrase in this homily, should be understood as equivalent to “living in accordance with the cross.”

If this interpretation is correct, then we find that Gregory’s argument turns not on the fact that the Maccabean martyrs achieved honor in a general sense, but on the particular kind of honor that they achieved, viz., that which comes from living in accordance with the cross. Moreover, Gregory provides evidence that the Maccabean martyrs lived in accordance with the cross by describing them in terms that would have been familiar to his audience from Christian martyrdom literature: e.g., he states that Eleazar “offered himself up to God as a perfect sacrifice” (§3); he says that the mother was “racked by the fear that [her sons] would not suffer” (§4), rather than by the fear that they would; and he describes the seven brothers as having won “the crown of martyrdom” (§9).<sup>9</sup>

In sum, Gregory argues that since the Maccabean martyrs achieved honor by living in accordance with the cross, Christ must have been known to them. And this was possible, even though they lived in pre-Incarnation history, because Christ is the eternal Logos, who has existed from “the beginning.”<sup>10</sup> Gregory thus justifies the veneration of the Maccabeans as Christian martyrs by establishing continuity between pre-Incarnation and post-Incarnation history through the figure of Christ, the eternal Logos, who revealed himself to all in the Incarnation, but also previously to the “pure of mind” (§1).

### John Chrysostom

In John Chrysostom’s homily *De Eleazaro et septem pueris*, we find a more developed justification

for the Christian cult of the Maccabean martyrs. John felt the need to guide his community because some of them had been convinced—“swept along by the Church’s enemies,” as John puts it (§4)—not to venerate the Maccabean martyrs. The reason for this? “They did not shed their blood for Christ but for the Law and the edicts that were in the Law, in that they were killed over pig’s flesh” (§4). In response to this argument, John, like Gregory, attempts to make the Maccabean martyrs worthy of Christian veneration by demonstrating the continuity of pre-Incarnation and post-Incarnation history through the figure of Christ. Yet his approach differs from Gregory’s in that he emphasizes Christ’s identity as Legislator, rather than Logos.

John begins his homily with a panegyric to the Maccabean martyrs’ courage. He claims that they are “even more brilliant” than the rest of the Christian martyrs because they were martyred before the Incarnation (§5). The Maccabean martyrs are especially remarkable, according to John, because “even those who were extremely just” (such as Moses and Abraham) feared death before the Incarnation (§5). Yet John does not simply wish to prove that the Maccabean martyrs were admirable in their actions; rather, his goal is to demonstrate “that they received their wounds for Christ’s sake (υπερ Χριστον τα τραύματα ελαβον),” that they were, to put it plainly, Christian martyrs (§6).

John’s basic argument to this end is straightforward. His first premise is that the Maccabean martyrs suffered “because of the Law and the edicts that lie within the Law” (§6). His second premise is that “it was Christ who gave that Law”—i.e., “that Law” for which the Maccabean martyrs died according to the first premise (§6). On the basis of these premises, John reaches the following conclusion: “By suffering for the Law, they displayed all of that boldness for the Lawgiver [who is Christ, according to the second premise]” (§6). John assumes the first premise to be unquestionable, which seems reasonable, since those who disagree with him regarding the Maccabean cult do so precisely because they agree with this first premise. Obviously, then, John’s major task is to prove the second premise: that it was Christ who gave the Law for which the Maccabean martyrs died.

In order to demonstrate that it was Christ who gave the Law, John refers to 1 Cor. 10:4, in which Paul writes that Moses and the Israelites “drank from the spiritual rock that followed. And the rock was Christ”

(§6). John thus demonstrates that he is not alone in identifying Christ as the Lawgiver of the old Covenant, but that he stands upon Scriptural precedent. Yet John recognizes that this argument might not be compelling to all—especially not to Jews—so he instead directs his audience’s attention to the book of the Jewish prophet Jeremiah.<sup>11</sup> John is particularly dependent upon Jer. 38:31-2 (LXX): “Behold, the days are coming, says the Lord, and I shall make a new Covenant with you, one unlike the Covenant which I made with your fathers.” In view of this verse, John asks who gave the new Covenant. He assumes that all will agree “without a doubt” that it was Christ (§7). Thus, since (a) the passage from Jeremiah implies that “the Legislator of both Covenants is one and the same” (§7), and (b) the Legislator of the new Covenant was Christ, John concludes that Christ must have also been the Legislator of the old Covenant.

Of course, one could object that the “new Covenant” of which Jeremiah spoke is different from the “new Covenant” that Christ gave. Yet John anticipates this objection by highlighting three “distinguishing features” of the new Covenant given by Christ: (i) “that it wasn’t given on stone tablets but that it was given on tablets of flesh, our hearts,” which is evidenced by the descent of the Holy Spirit at Pentecost; (ii) “that the Word raced with ease and lit up everyone’s mind,” which is evidenced by the rapid spread of Christianity; and (iii) “that when the Law was dissolved, no one demanded payment for sins but each received forgiveness for their wrongdoings,” which is evidenced by baptism and the forgiveness that comes through grace (§14). These features, John claims, are consistent with the three key features of the new Covenant described in Jer. 38:33-4.<sup>12</sup>

Thus, John argues that the new Covenant given by Christ is the same as the new Covenant that Jeremiah foretold. And since Jer. 38:31-2 proves that the Legislator of the old Covenant is the same as the Legislator of the new Covenant, John is able to conclude that those “people who were killed for the Law shed their blood for the giver of the Law,” i.e., for Christ (§16). What John does, then, is rely upon Christ’s identity as Legislator in order to demonstrate that Christ was present in pre-Incarnation history and, more importantly, that the Maccabeans should be regarded as Christian martyrs, since they died for Christ.

### Augustine of Hippo

Augustine’s homily *In solemnitate martyrum Machabaeorum* offers another well-developed justification for the Christian cult of the Maccabean martyrs. The basic approach of Augustine, as with both of the previously examined homilists, is to establish continuity between pre-Incarnation and post-Incarnation history through the figure of Christ, so that the Maccabean martyrs may be viewed as worthy of veneration alongside the post-Incarnation Christian martyrs. Augustine’s approach is distinctive, however, in that he emphasizes Christ’s role as the turning point of sacred history.

The sacred history that Augustine is interested in exploring is the history of the relationship between God and his people. As a Christian, Augustine believes that Christians are God’s people. Yet he asserts that we should not suppose “that before there was a Christian people, God had no people” (§1). The people of Abraham were also God’s people, according to Augustine; but they were not God’s people apart from Christ. This would be impossible, for Augustine understands God’s people to be equivalent to Christ’s people. Thus, Augustine claims that the people of Abraham were the people of God precisely because they were the people of Christ: “it wasn’t only after his passion that Christ began to have his people; his too was the people born of Abraham” (§1). Likewise, regarding the Maccabean martyrs, Augustine proclaims that “when you are admiring these martyrs, you shouldn’t think they weren’t Christians. They were Christians; but with their deeds they anticipated the name of Christian that was publicized much later on” (§2).

Augustine recognizes, however, that it might seem strange to identify pre-Incarnation Jews as Christians, especially since “as though it wasn’t Christ they were confessing, they were not being forced by the godless king and persecutor to deny Christ” (§2). Thus, in order to justify his claim that the Maccabean martyrs should be viewed as Christians, he sets forth a principle that unifies pre-Incarnation and post-Incarnation history: “The Old Testament, you see, is the veiling of the New Testament, and the New Testament is the unveiling of the Old Testament (*Testamentum enim vetus velatio est novi Testamenti, et Testamentum novum revelatio est veteris Testamenti*)” (§3). On the basis of this principle, Augustine argues that the Maccabean martyrs did not openly confess Christ because “the mystery of Christ

was still concealed behind a veil” (§3). Following the teaching of the Apostle Paul on unveiling (cf. 2 Cor. 3:14-6), Augustine understands sacred history to have been fundamentally changed by the Incarnation of Christ. Christ is, according to Augustine, the very turning point of sacred history.

In order to demonstrate the unveiling that was effected in Christ, Augustine highlights Christ’s conscious fulfillment of Old Testament prophecies about his Passion, even minor prophecies such as “in my thirst they gave me vinegar to drink” (Ps. 69:21). Augustine also notes how, with Christ’s death, “the veil of the Temple was torn away,” an event which demonstrated that “now was the time for everything that was veiled in the Old Testament to be unveiled and revealed in the mystery of the cross” (§4). Thus, Augustine presents a narrative in which all of sacred history is connected to Christ’s Incarnation.

As for why the Maccabean martyrs are properly identified as Christian martyrs, Augustine offers the analogy of “a Very Important Person (potentissimus) traveling along with a troop of attendants, some going in front, others going behind” (§5). According to Augustine, “both those who march ahead are attentive to him and those who follow behind are devoted to him” (§5). In other words, one could bear witness to Christ whether one lived before the Incarnation or after it.

Augustine thus argues that all of sacred history is connected to Christ, who stands at the center of it. Through this narrative of sacred history, Augustine is able to affirm that the Christian martyrs “confessed plainly the same one as the Maccabees at that earlier time confessed in a hidden manner; the former died for Christ unveiled in the Gospel, while the latter died for the name of Christ veiled in the Law” (§5). The Maccabean martyrs, by being devoted to the Law, are an undeniable part of sacred history. Moreover, Augustine can confidently claim that “the Maccabees really are martyrs of Christ” (§6), because through their devotion to the Law they were actually devoted to Christ, who was veiled in the Law.

## Conclusion

Thus, we have seen that Augustine’s justification for the cult of the Maccabean martyrs is distinctive because he emphasizes Christ’s identity as the turning point of sacred history. This differs from what we found in the homilies of Gregory of Nazianzus and John

Chrysostom, who emphasize Christ’s identity as Logos and Legislator, respectively. Nevertheless, the three homilists share a basic approach: they all attempt to establish continuity between pre-Incarnation and post-Incarnation history through the figure of Christ, so that they may thereby justify the veneration of the Maccabean martyrs as Christian martyrs. These conclusions beg for further investigation into the relationship between the theological justifications of these homilies, on the one hand, and popular devotional practices related to the Maccabean martyrs, on the other. But such an investigation will unfortunately have to wait for another time.

## Notes

1. My deepest thanks to Prof. Maud Gleason, without whose advice and enthusiasm this essay would not have been written. Also, I would like to thank Mira Balberg and Prof. Bob Gregg for their helpful suggestions.

2. I use the term “Maccabean martyrs” simply because it is the most recognizable way of referring to the individuals in question. I do not mean to imply that they were part of the Hasmonean family. The term derives from those texts which contain the earliest written accounts of the martyrs, viz., 2 Maccabees (6:18-7:42) and 4 Maccabees (the entire book). J. W. van Henten dates 2 Maccabees to ca. 125 BCE and 4 Maccabees to ca. 100 CE. VAN HENTEN, JW. *The Maccabean Martyrs as Saviours of the Jewish People: A Study of 2 and 4 Maccabees*. Leiden: Brill, 1997: 4.

3. The Mosaic Law prohibits consumption of pork in Lev. 11:7-8. The Christian abandonment of Mosaic dietary prohibitions was grounded in the teachings of the Apostle Paul: “Eat whatever is sold in the meat market without raising any question on the ground of conscience, for the earth and its fullness are the Lord’s” (1 Cor. 25-26).

4. Theoph. ep. 100.9. In: RUSSELL N, trans. *Theophilus of Alexandria*. London: Routledge, 2007: 150.

5. E.g., scholars disagree as to whether there was a Jewish cult of the Maccabean martyrs prior to the Christian cult. M. Schatkin assumes this to be true, as does R. Wilken. In contrast, L. V. Rutgers considers the possibility of a Jewish cult to be “very remote,” and G. Rouwhorst agrees with him. SCHATKIN M. *The Maccabean Martyrs*. *Vigiliae Christianae* 1974; 28, no.

2: 97-113; WILKEN R. *John Chrysostom and the Jews: Rhetoric and Reality in the Late 4th Century*. Berkeley: University of California Press, 1983: 88ff; RUTGERS LV. *The Importance of Scripture in the Conflict Between Jews and Christians: The Example of Antioch*. In: Rutgers LV et al., eds. *The Use of Sacred Books in the Ancient World*. Leuven: Peeters, 1998: 287-303; ROUWHORST G. *The Cult of the Seven Maccabean Brothers and their Mother in Christian Tradition*. In Poorthuis M. *Saints and Role Models in Judaism and Christianity*. Leiden: Brill, 2004: 183-204.

6. A Syriac martyrology that was likely written in the middle of the fourth century—with a terminus ante quem of 412—provides us with probably the earliest reference to the Christian cult of the Maccabean martyrs. See WRIGHT W. *An Ancient Syrian Martyrology*. *Journal of Sacred Literature* 1865; 8, no. 15: 45-56; also, WRIGHT W. *An Ancient Syrian Martyrology [English translation]*. *Journal of Sacred Literature* 1866; 8, no. 16: 423-432. For Gregory of Nazianzus' homily *In Machabaeorum laudem* (hom. 15), I used the translation in VINSON M, trans. *Select Orations. The Fathers of the Church: A New Translation* 107. Washington, DC: Catholic University of America Press, 2003: 72-84. For John Chrysostom's homily *De Eleazaro et septem pueris*, I used the translation in MAYER W, trans. *The Cult of the Saints*. Crestwood, NY: St. Vladimir's Seminary Press, 2006: 119-134. For Augustine of Hippo's homily *In solemnitate martyrum Machabaeorum* (serm. 300), I used the translation in HILL E, trans. *Sermons 273-305A: On the Saints. The Works of Saint Augustine: A Translation for the 21st Century* 8:3. Hyde Park, NY: New City Press, 1994: 276-281. There are two other homilies by John Chrysostom on the Maccabean martyrs (known as *De Maccabeis I* and *De Maccabeis II*), but I did not address them in this essay because they do not provide explicit justifications for the Maccabean cult.

7. Gregory's emphasis upon Christ as the Logos

makes a great deal of sense, for Gregory's source text is 4 Maccabees, a book whose stated purpose is to demonstrate that "devout reason is sovereign over the emotions" (4 Macc. 1:1).

8. This line of questioning is especially relevant if we recognize Gregory's affinity for classical Greek culture, an affinity made obvious by his allusions to Homer's *Iliad* in this very homily. See §4 and §8.

9. This sort of rhetoric can be found throughout Christian martyrdom literature. Cf. the excellent English translations in MUSURILLO H. *The Acts of the Christian Martyrs*. Oxford: Clarendon Press, 1972.

10. Jn. 1:1.

11. As the text being examined was a homily, it is unlikely that there were any Jews in the audience when it was preached. It is possible, however, that there were some among John's congregation who were "Judaizers." This is a term that referred to Christians who engaged in Jewish practices and rites, and it was on account of these people that John preached his infamous series of homilies titled *Against the Jews*. The present homily was preached in Constantinople, while the homilies *Against the Jews* were preached in Antioch; however, it seems likely, given John's effort to make an argument that would be acceptable to Jews, that John also felt threatened by the Jewish presence in his new locale. On John Chrysostom and Judaizers, see WILKEN R. *op. cit.*: 66-94.

12. According to Gregory, the first feature of the new Covenant given by Christ matches up with Jer. 38:33: "I shall place my laws in their mind and engrave them on their heart." The second matches up with the first part of Jer. 38:34: "Everyone, from the smallest to the greatest of them, will know me." And the third matches up with the latter part of Jer. 38:34: "I shall be merciful to their wrongdoings and I shall no longer store in my memory their sins and their lawless ways."



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# Exporting Criminality: Money Laundering in a Domestic and International Context

Joyce Dela Pena<sup>1</sup>

In an increasingly globalized world made smaller by the information and communication technology revolution, it has become ever more difficult to accurately monitor financial transactions. Money laundering, which sustains the financial activities of organized crime, is particularly problematic; with the click of a button, extraordinary sums of money can be transferred from a drug cartel in Brazil to an anonymous bank account in Antigua. Thus, anti-money laundering measures across national borders focus primarily on countering those technological advances that enable money laundering to continue. However, taking a postmodernist approach, I argue that the practice of money laundering today is not, in fact, the sole function of advances in technology. Rather, money laundering has evolved in reaction to the process of criminalization, crossing international borders and thereby creating a highly profitable shadow economy in previously impoverished nations. Taking US policies as my case study, I examine how the practice of money laundering has been shaped by current anti-money laundering processes.

In an increasingly globalized world, the international system of states, corporations, and private individuals has come to resemble a dense web connected by transnational transactions, wherein many actors have multiple national links and identities. Globalization, along with the information and communication technology (ICT) revolution, has contracted the temporal and spatial dimensions on which human activity occurs. As a result of globalization, any action, no matter its territorial origin, can immediately impact events on the other side of the globe. Human activities, no longer bounded by geographical space, can reach any part of the world, cancelling the physical distance in between while astronomically reducing the time necessary for carrying out the action itself.<sup>1</sup> Economically, this is reflected in the speed with which international money transfers take place, the complex structure of financial contracts, and the multi-country networks of international corporations.

Yet this information revolution is not without

consequences. ICT, coupled with financial liberalization and the removal of capital controls, provides opportunities for criminals to use international markets for illicit activities.<sup>2</sup> Drug trafficking, human trafficking, and arms sales take place in an underground economy made possible by the conveniences of ICT. Money laundering functions as a critical nexus connecting the 'shadow economy' of these criminal activities with the economically regulated world. Utilizing the high-speed, border-spanning telecommunications networks of the digital age, criminals can more easily obscure the illegal source of their profits and thus use tainted money in the legitimate financial system. Consequently, law enforcement agencies, regulatory authorities, and policymakers worldwide bemoan the insufficient capacity of anti-money laundering (AML) measures to counter such technological advancements.

How critical is the information revolution to the spread of money laundering across borders and the consequent failure of AML processes? Recent domestic and international AML initiatives focus their resources on closing the technological gap, mainly by constructing an enhanced monitoring and surveillance system within existing financial institutions. In effect, they are fighting fire with fire; states hope to find the cure for a problem in the very technology that seems to breed it.<sup>3</sup> Yet while the digital age has greased the wheels of the money-laundering machine, it is itself not responsible for the configuration of that machine. Rather, money laundering has evolved in *reaction* to AML policies. The shape of money laundering today is not, in fact, the sole function of technological advancements, but of the process of criminalization itself. Domestic policies, specifically those in the United States, inspired new approaches to money laundering, shifting the network of complicit banks and companies to states whose lenient policies allowed and subsequently came to depend on the profitability of criminal activity. Thus, the greatest obstacle to successful AML policies is not new technology, but the reluctance of these 'safe haven' states to enact sincere AML legislation.

## Money laundering: structure and significance

Money laundering involves the transfer of a

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significant amount of currency over a vast transnational network composed of banks, companies and private actors. By some estimates, \$1 billion USD of criminal profits are exchanged in the world's financial markets each day. The annual sum of drug profits moving through the U.S. financial system alone may be as high as \$100 billion USD.<sup>4</sup> Michael Camdessus, former director of the International Monetary Fund, estimates that in 2000 the yearly global value of illicit money laundered constituted between two and five percent of world production – roughly between billion and \$1.8 trillion USD.<sup>5</sup> These funds represent both the assets of criminal activity and their financial source, because criminal actors reinvest their profits into the activities that initially generated them. This cycle “is the lifeblood of organized crime;”<sup>6</sup> terrorists need money to buy weapons and bombs, drug smugglers need money to pay off customs and immigration inspectors, and weapons traffickers need money to purchase and transport their arms.<sup>7</sup> These criminal actors turn to the churning of the legitimate financial system to ‘clean’ their dirty money so that it may be used freely.

The money laundering process typically involves three stages: placement, layering and integration. First, criminals introduce large amounts of illegally obtained cash into the financial system through smaller and less conspicuous deposits or money transfers or through the purchase of high-dollar goods. The purpose is to transform the money into other kinds of assets as quickly as possible. In the layering step, money transfers circulate illicit funds through various financial institutions and across multiple jurisdictions in order to obscure their source and ownership.<sup>8</sup> These electronic funds transfers are by far the most common layering technique.<sup>9</sup> In the final step of the process, funds are integrated into the mainstream financial world, often by conversion into financial instruments (stocks and bonds), the purchase of real estate, or investment in legitimate businesses.<sup>10</sup>

### **Domestic AML: The case of the United States**

The United States was the first nation to officially criminalize money laundering with the Money Laundering Control Act of 1986, which made money laundering a federal crime.<sup>11</sup> Since then, U.S. domestic AML measures have been two-pronged, focusing on both prevention and repression of money laundering. This article focuses primarily on the prevention aspects

of AML, which target ‘choke points’ – stages in the process that the launderer finds difficult to avoid and that are vulnerable to detection – within the placement and layering phases of the money laundering process. This legislation seeks to engineer regulatory and surveillance mechanisms within the financial system.

The first choke point in the money laundering system is the placement stage. Law enforcement agencies can identify money launderers if they detect a large amount of funds transferred by financial institutions. To this end, the Bank Secrecy Act of 1970 requires banks to file currency transaction reports (CTRs) on all deposits of \$10,000 or more.<sup>12</sup> Furthermore, the Money Laundering Suppression Act of 1994 requires all banks to file additional suspicious activity reports (SARs) if it suspects that money laundering may be taking place.<sup>13</sup> The U.S. PATRIOT Act, in an attempt to combat the terrorist-financing aspect of money laundering, extends both of these requirements to a host of other institutions, including casinos, money transmitter services, car dealers and insurance companies.<sup>14</sup> The Financial Crimes Enforcement Network, created in 1990, is specifically responsible for analyzing the SARs and CTRs from the 21,000 depository institutions and 200,000 non-bank financial institutions.<sup>15</sup> Title III of the PATRIOT Act, the International Money Laundering Abatement and Anti-Terrorist Financing Act of 2001, also established a “know your customer” (KYC) requirement for financial institutions, compelling banks to collect specific information to verify the identity of their customers and to conduct due diligence, namely comparing customers’ transactions to their recorded profile and customer history. Organizations that fail to comply with these requirements or else participate in money laundering – with or without knowledge – face large monetary penalties of up to \$50 million from the Treasury Department.<sup>16</sup>

Reporting requirements enacted in 1996 target the ‘layering’ stage. These force domestic banks to include all identifying information in the payment order of wire transfers. Identifying information thus travels with the transfer from the first bank to the last, thereby preventing launderers from obscuring the origins of their funds with the cycling of wire transfers.<sup>17</sup>

### **Crossing borders: transnational money laundering**

The failure of these measures to successfully combat money laundering illustrates a key aspect of

the crime, namely its ability to react to AML initiatives and evolve accordingly. For example, in order to avoid the \$10,000 threshold for CTRs, criminal actors simply “smurf” funds into the system – multiple individuals make a large number of small deposits and then later aggregate those funds into a single larger account.<sup>18</sup> Money launderers also use means outside of the financial system that may not even involve ICT developments. Trade-based money laundering, for instance, is the process of disguising the proceeds of crime using trade transactions wherein the price, quantity, or quality of imports and exports are misrepresented.<sup>19</sup> Thus, the growth of trade based money laundering has little relation to ICT, but is instead a function of the reactive nature of money laundering.

Most significantly, U.S. domestic AML initiatives have failed because they have forced money laundering to migrate across borders, thus contributing to the transnational nature of the crime. Given the increased regulation in the U.S. financial system, it is not surprising that criminal activity shifts to states where the risk of detection and expected sanction are lowest.<sup>20</sup> In other words, the existence of controls has made it necessary for money launderers to circumvent them, utilizing convenient technological developments in the process. Wire-transfers provide a simple illustration of this phenomenon: because of the institution of the 1996 reporting requirements, criminal actors can no longer use wire transfers between U.S. banks to obscure the origin of their funds. However, wiring a transfer through a foreign bank that has strict bank secrecy easily solves this problem – the identifying information is erased and the wire transfer leaves the foreign bank clean. This one step foils the efforts of U.S. reporting requirements as it allows criminal financing to continue unchecked. Because AML initiatives target criminals through the disruption of their financing, the fact that it continues outside of U.S. territorial borders regardless of U.S. domestic efforts renders much of these AML measures useless.

Given that transnational money laundering involves the utilization of resources in foreign states with lax regulatory systems, ICT technology serves a critical function. In a world shrinking as a result of digital technology, remote banks are just as easily accessible as the one next door. Offshore financial centers serve as “safe havens” for international criminal organizations – such centers are the sites of shell

companies, international business companies, offshore trusts, and rogue banks through which criminals can and do run their illicit funds.<sup>21</sup> For instance, some launderers take advantage of bank secrecy at these locations, which criminalizes the release of customer information, in order to scatter money across multiple accounts. Offshore shell banks have professional relationships with banks in more highly regulated, legitimate businesses, allowing the criminal customer to take advantage of the financial structure of the more highly regulated bank. The instantaneous wire transfer of funds, a direct result of globalization, is the string that ties the operation together.<sup>22</sup> Alternatively, criminals can use anonymous offshore shell companies to receive illicit funds through seemingly legitimate business arrangements. Indeed, most money laundering schemes involve a series of complex financial transactions moving funds through more than one of these offshore financial centers. While an investigating agency can sometimes spot the path of questionable funds flowing into and out of such a scheme, if the foreign country will not disclose the necessary identification information, the exact links between the funds and the illegal act that generated them are entirely lost.<sup>23</sup>

### **Exporting criminality: international AML**

In light of the transnational character of money laundering and America’s persistent domestic interest in halting such crimes, in the 1980s the U.S. exported its criminalization of money laundering into the international arena. The 1988 Vienna Convention on Narcotics – opened for signature at the height of the American fixation with preventing drug smuggling and on the coattails of the U.S. 1986 Anti-Drug Abuse Act – compelled countries to directly target narcotics trafficking through new criminal statutes, prosecutions, and extraditions. As part of this measure, it encouraged states to establish money laundering as a crime.<sup>24</sup>

Similarly, the U.S. spearheaded the creation of the Financial Action Task Force by OECD countries in 1989. This institution uses a ‘name and shame’ approach to pass judgment on countries, both members and nonmembers, regarding their controls over money laundering. A set of graduated sanctions backs up the system of mutual review, varying from a scolding letter, to expulsion from the Financial Action Task Force (FATF).<sup>25</sup> Furthermore, in its “Forty Recommendations,” FATF calls on states to ratify the 1988 Vienna Convention,

prohibit anonymous accounts, adopt effective seizure and forfeiture laws, and sanction non-cooperative nonmembers.<sup>26</sup> More concretely, in 2000, the finance ministers of G7 countries threatened that if institutions on the FATF list did not take immediate steps to fight money laundering, the G7 would consider additional measures, such as restricting financial transactions with those jurisdictions and conditional support from financial institutions.<sup>27</sup>

Shortly after the September 11 terrorist attacks on the US, the UN Security Council passed a resolution requesting that UN members cooperate in the fight against terrorist financing and ratify the Convention for the Suppression of Terrorist Financing.<sup>28</sup> The Convention requires countries to criminalize terrorist financing and to establish mechanisms that allow authorities to freeze the assets of charities, businesses and individuals believed to be financing terrorism.<sup>29</sup>

This carrot and stick, multilateral ‘soft law’ approach has experienced some success. States have been ‘shamed’ by international pressure into instituting minimal AML standards. By the beginning of 2001, seven of the 15 targets of FATF action – the Bahamas, the Cayman Islands, the Cook Islands, Israel, Lichtenstein, the Marshall Islands and Panama – had reinvented their AML policies. For example, money laundering is now a crime in Israel and customer identification is mandatory in the Cayman Islands.<sup>30</sup> Further, FATF members and non-members are trying to adopt its recommendations to combat terrorist financing.<sup>31</sup> Nevertheless, several countries continue to resist implementing AML and CTF initiatives; in its most recent jurisdictional review of non-cooperative countries and territories, the FATF listed 23 states as non-cooperative.<sup>32</sup>

### **Shortcomings of international AML: non-cooperative states**

Strategies using FATF and other transnational measures may force some states to make superficial changes in their laws, but new criminal statutes rarely achieve lasting differences in enforcement patterns. While almost all industrialized countries now agree that money laundering is a crime, few have regulations as broad as those used in the US approach. Only some states have instituted comprehensive reporting of all cash transactions above a threshold amount as most banks have lobbied their governments to reject this style of record-keeping and reporting.<sup>33</sup> States either do

not want to enforce AML measures, or are unable to do so. Given that the U.S. Treasury Department operates the largest currency transaction reporting system in the world, at an estimated cost to the banking industry of \$136 million annually,<sup>34</sup> it is no surprise that developing nations with severely limited resources cannot even come close supporting U.S.-like measures.

Some smaller jurisdictions have a vested interest in not enforcing AML: their role as off-shore financial centers allows them to compete for funds in the world market. As a result of the migration of criminal finance across borders, remote and resource-poor nations like Nauru, Niue, Vanatu, Antigua, Barbuda and Bahrain have moved from the fringes of the international banking system to full integration in the global economy,<sup>35</sup> and the banking industries in these countries constitute a relatively large part of the GDP.<sup>36</sup> Therefore, the economic incentive to pursue lax policies is strong and persists regardless of the rise of the international apparatus against money laundering. Indeed, one can argue that strict regulation in certain states actually *creates* the opening and high profitability of rogue banking in foreign jurisdictions. Moreover, the constitutive acts of money laundering – opening bank accounts, wiring funds, and moving assets through companies – are not in themselves crimes. Money laundering is a derivative offense: its criminality is a function of the predicate crime (i.e. drug production, arms trafficking, terrorism). If there is no consensus on the harmfulness of the predicate crime – for instance, drug production in Columbia – there is little incentive to view money laundering related to that specific offence as a pressing national interest.

The international criminalization of money laundering and the subsequent reluctance of certain states to implement AML measures evidence the problems inherent in exporting Western definitions of criminality. U.S. domestic interests in protecting the stability of the U.S. economy and fighting terrorism drive international AML initiatives at almost every turn. While money laundering indirectly undermines the world economy and finances predicate crimes that are of international concern, in the case of safe haven states, negative externalities – the spillover effects caused by the economic transaction – are either removed from the state, or else the state tolerates the crime for its economic benefits. Just as legal casino gambling in Monte Carlo and narcotics farming in Columbia support

local employment and state economies,<sup>37</sup> so too does rogue banking provide government revenue and confer benefits on the public.

Exportation of criminality illustrates a postmodern understanding of criminology: the process of naming and combating the crime of money laundering has exacerbated the crime as we know it today. The institution of governmental controls forces money launderers to circumvent those controls, utilizing ICT developments and global currents to do so. Thus, money laundering has assumed a far more transnational character than in the past. Furthermore, state-created restrictions on U.S. banks have contributed to the profitability of off-shore banking havens. Subsequent attempts to export foreign notions of criminality to regions that do not share the Western social values or policies illustrate the fact that crime is a social construct controlled by established norms of a society. Individual nations will only enact the costly and privacy-reducing regulations that constitute AML measures if they are motivated by their own domestic interests.

### **Conclusion: a realist defense**

The purpose of this analysis has been to illustrate the causal connection between three phenomena in the money laundering process: 1) the way in which Western states' domestic criminalization has unintentionally shaped the crime by forcing it across borders; 2) how these enforced laws create the openings for and high profitability of off-shore financial havens; and 3) given these financial boons and the fact that the impetus for criminalization did not arise in their jurisdictions, non-compliant states have little incentive to enact AML regulations. The question of regulating money laundering, therefore, does not hinge on the U.S.'s ability to keep up with ICT developments, but on whether safe haven states will impose any regulation at all. While ICT certainly lubricates the money laundering process, the ability of states to stop money laundering depends on the establishment of a harmonized regime of crime control. Disparities between states' national policies will create opportunities for money launderers to continue financing their nefarious acts, and thus AML initiatives cannot succeed if small off-shore financial havens continue to pursue their own capitalist interests.

Political realism asserts that states first and foremost pursue their own interests. Arguably, the

U.S. is attending to its own domestic protection concerns – though its approach presumably benefits the international community as well– and safe haven states are similarly pursuing their own economic gains. Indeed, it is not clear whether the threat that rogue banking poses to the developed world is significantly or at all more damaging than the history of colonialism and economic exploitation by developed nations. Regardless, a state's ability to pursue its own interests in an international context depends on the power behind that state. Thus, states, like the US, who are concerned with non-cooperative safe haven nations, can raise the incentives for cooperation through political coercion. Thus far, the FATF's multilateral approach of political pressure on the part of the developed world has been quite successful. Another possible approach is the unilateral widening of criminal jurisdiction. The United Nations Convention Against Corruption and the UN Convention Against Transnational Organized Crime establish jurisdiction where the offence in question is committed in whole or *in part* in the territory of the prosecuting state party.<sup>38</sup> If an individual draws a check connected to money laundering on American soil, the U.S. can bring the entire case within its jurisdiction. Furthermore, the Conventions provide optional criteria with which states can consider establishing jurisdiction in additional instances: for example, when the offence is committed against<sup>39</sup> or by<sup>40</sup> one of their own citizens, the offence is linked to money laundering planned to be committed in state territory,<sup>41</sup> or the offence is committed against the State party.<sup>42</sup> In recent years, the U.S. has expanded its jurisdiction without precedent, mainly to prosecute US nationals who commit crimes outside of traditional US jurisdiction (i.e. sex tourism laws). While expanding jurisdiction to prosecute non-nationals outside of U.S. jurisdiction for attempted money laundering against the state has not been attempted, it is not impossible. Indeed, between the question of power and profit, perhaps the mere threat of expansive U.S. criminal jurisdiction may be a sufficient incentive for non-compliant states to make AML a domestic concern.

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# Examining Empowerment among Indian Widows: A Qualitative study of the Narratives of Hindu Widows in North Indian Ashrams<sup>1</sup>

Nimi Mastey\*

Contemporary discourse on widowhood in India tends to concentrate heavily on quantitative evaluation. Discussion of the narratives of the women is confined to more popular medium, and tends to focus on the need of the women to be empowered. By simply visiting ashrams in Vrindavan it becomes clear that the term “empowerment” is vastly up to interpretation. This study focuses on the models of empowerment applied by two different widow ashrams: Ma-dham and Chetan Bihar. Through obtaining narratives of the women’s lives, I attempt to assess the success of the ashrams in “empowering” the widows, and question the necessity and implications of this empowerment. There seems to be no unified vision of what constitutes empowerment for any two women to the extent that while most dislike the state of widowhood, a significant and surprising number seem to prefer widowhood to marriage. In all, “empowerment of women”, a phrase used by nearly every women’s organization, is ambiguous and at times misused. In analyzing the situation of widows in Northern India, there emerges the need to distinguish between personal power and external empowerment by researchers in the field, as well as by the ashrams working to alleviate social injustice.

Widowhood in India is often described as a definitive and tragic moment in a women’s life—one in which her identity is stripped away with the death of her husband. As early as the second century BCE, the Laws of Manu, an influential text in Hindu scripture, had created a set of structured gender relations in the Brahmin caste. Included in the text are the statutes that a widow must remove all excess adornments, observe fasts, eat limited meals each day, forgo hot foods, replace the red sindoor<sup>2</sup> on her forehead with ash from her husband’s funeral pyre, and observe tonsure<sup>3</sup>. The same text also pronounces that a woman who is widowed cannot remarry. The ideal Hindu widow remains with her in-laws—a result of the patrilocal<sup>4</sup> system of marriage in most of India—embodying this state of holy asceticism. This system of marriage

places women in a situation of vulnerability after their husband’s death, particularly if they do not earn income: they can neither reintegrate with their parental family, nor do they necessarily receive adequate support to live contentedly in their husband’s village.

Within the normative structure of Brahmin<sup>5</sup> gender roles is the assumption that the ban on remarriage of widows is reserved as a privilege for the higher castes<sup>6</sup>. Less acceptable forms of marriage, derived from the eight forms listed in the Hindu shastras were ascribed to the lower castes, namely a system of remarriage known as *pat* which is prevalent among the agriculturalists<sup>7</sup>. Because women in these societies are seen as producers—and reproducers of producers—their continued sexual activity after widowhood is viewed in parallel to the success of their economy<sup>8</sup>.

For these reasons, a historical divide has been created between terms of widowhood for the higher and lower castes. While this ancient delineation of widowhood is still considered an idealized space for a widow to inhabit, the extent to which any given woman adheres to these structures today is largely dependent upon a variety of factors, including socio-economic status.<sup>9</sup> Because of these financial considerations, many widows from lower-income families are not able to remain in the house of their in-laws without working or, in some circumstances, getting remarried. Oftentimes, if these women cannot, or do not wish to, work or remarry, they will leave their family structure for a variety of reasons. Some of these include, but are not limited to, a desire to relieve the burden on their family, a lack of connection to their in-laws or children, or a wish for independence from a life of familial ties. Hindu widows commonly relocate to religious pilgrimage sites, including Vrindavan and Varanasi—the birthplaces of Lord Krishna and Lord Shiva, respectively.

Needless to say, lifestyles and identities adopted by widows are highly individualized, and essentially no two women’s stories are exactly the same. Perhaps the most difficult factors to assess among these actions are those of personal choice and empowerment. If a widow leaves her house after her husband’s death, rather than remain with either her children or her in-laws, is that a matter of choice? Is the widow who leaves her family

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more or less empowered than the woman who stays? How subjective is empowerment, and can we ever define it objectively? Can we, as researchers, ethically define empowerment for another group of people, or is there an aspect of condescension in doing so?

This paper will elaborate on the methodology of this study, the meanings and assumptions in the term *empowerment*, media misconstructions of the term, and an exploration of how ashrams use and define empowerment. The basis of this paper is primary data collected through interviews in Chattikara and Vrindavan, Uttar Pradesh, India. I will attempt to reshape the rhetoric around the phrase “empowerment of women” through the interviews I have conducted with widows, as well as through contextual analysis of previous research and popular portrayals of the subject. In all, I argue that using the mentality of empowerment when attempting to facilitate the success of women, in this case widowed women, can debatably be a disempowering act. There is a need to look through a lens of subjectivity as defined by the women, themselves, as well as to distinguish between personal and external notions of empowerment.

### Methodology and Background

In this project, my choice to privilege the narrative over quantitative data is due to the dearth of contemporary individual perspectives on widowhood; the most recent personal accounts of widowhood date to the post-colonial era in Indian history, which presented a much different set of concerns. Most of the post-colonial texts focus on issues of *sati*<sup>10</sup>, the conflict between the views of the colonizers and colonized, and the space that widows occupied in the vacuum left after the end of the British rule. Contemporary accounts, as evidenced in my research, focus more heavily on the effect of sensationalization of the empowerment of widows in popular media and the effects of ashrams to quality of life.

The primary method of gathering data in this study was through individual interviews conducted with widows in two ashrams: *Ma-Dham* in Chattikara and *Chetan Bihar* in Vrindavan. Eighteen widows in *Ma-Dham*, and eleven in *Chetan Bihar* were interviewed. I lived in *Ma-dham* for four weeks, observing interactions among the women and with the institution and administration. After expanding and organizing field notes and transcribing interviews, the data from

the interviews was analyzed based on patterns in the narratives. The interviews were coded based on the following categories: 1) reasons for leaving home, 2) marital status 3) desire to stay in ashram, and 4) notions of empowerment. Before I begin the analysis of the narratives, I will give some context to the two ashrams.

*Ma-Dham* is an ashram approximately two kilometers outside the city of Vrindavan (in Chattikara) and is run by the non-governmental organization, The Guild of Service. It houses over ninety widows, and is staffed full-time by two wardens, both of whom are younger women. Most of the widows in this ashram are over the age of sixty, and a large proportion of women are from the northeastern state of Bengal. The ashram is located in the middle of a large field, about half a kilometer away from the main road. To get to the city for stores, temples, etc., one must take an auto-rickshaw for ten rupees round trip. The women in this ashram receive food, shelter, and minimal clothing for free, and many are eligible for the government pension of three hundred rupees per month. In regards to personal mobility, the women need permission to leave the ashram, as well as to withdraw money from their accounts.

*Chetan Bihar* is a government-run ashram for widows located centrally in the city. The ashram houses over two hundred widows and the average age of the women is significantly younger than in *Ma-Dham*. Many of the women walk daily to the bhajanashrams<sup>11</sup> to sing twice a day and earn small amounts of money and food rations. In addition to the three hundred rupee pensions, they also receive five hundred fifty rupees per month for personal expenses. The women have personal kitchens to cook their own food. They share rooms with one to three other widows. The ashram is set up like an apartment complex with no restrictions on leaving and coming back.

### The Ambiguous and Indefinite Nature of the Term *Empowerment*

Defining what is meant by *empowerment* is arguably the most critical aspect of assessing what it means to *be* empowered, or *to* empower. Countless approaches to women’s empowerment have been proposed, each assuming varied and often irresolvable stances to the issue. The Harvard Center for Population and Development Studies suggests that three different methods of empowerment have been attempted

in South Asia: integrated development, economic empowerment, and consciousness-raising. These three trials each had their own theories about the source of women's lack of power, namely "greater poverty and lower access to resources, economic vulnerability, and subordination within patriarchal societies and socioeconomic inequalities."<sup>12</sup> Similarly, Professor Margot Breton at the University of Toronto argues that empowerment consists of five components: "social action, political awareness, the right to say and to 'have a say,' recognizing oneself and being recognized as competent, and the use of power."<sup>13</sup>

These definitions imply that empowerment means one was powerless to begin with. Additionally, because the definitions are created by institutions and not the people themselves, they imply a sense of hierarchy in which models of empowerment are enforced by an authority other than the individual. Because of these two reasons, institutional notions of empowerment function in a manner that is ironically disempowering. This raises the question of what exactly it means to be disempowered, and who decides an individual's state of power. Current research has not focused on the construction of the term empowerment itself and the inherent powerlessness it implies. While a recent study<sup>14</sup> in South India did explicate the potential dangers of social and economic empowerment of women in terms of increasing domestic violence rates, it did not focus on the meaning behind the term.

Based on interviews I conducted in North Indian ashrams, I propose the necessity to stray from these notions of "empowerment" and "disempowerment." Instead, in order to successfully address issues of human rights, it is more fruitful for organizations working on women's rights issues to identify and emphasize the personal power that many of the women possess, and work alongside them to facilitate their success. I will demonstrate through my field research that widow ashrams can benefit from recognizing the personal power of the women who live there and facilitating their success as individuals, rather than imposing a blanket model of empowerment on all women. In summary, there needs to be a shift from the ideology of empowering widows in ashrams, to an ideology of recognizing the inherent power they possess in leaving their homes. By shifting their ideologies in this way, ashrams can change the hierarchical structure they currently possess in helping widows become empowered, to a more

facilitative approach where they work with the women to assess their personal needs.

### **Ashrams and Empowerment: narrative evidence of the mismatch**

The concept of distinguishing these two ideologies for ashrams seems arbitrary until one examines their manifestations within a tangible context. An interview with Prem, a widow in *Ma-dham*, made the distinction quite clear:

*When I was In Delhi, I was living with my son who would not work, and spent all the money I earned from working at the bank on alcohol, tobacco, and gambling. I had to leave him and so I asked my assistant to find out names of ashrams for me. She found out about the Guild of Service and I left one night, without telling anyone in my family [...] In the ashram I am safe but I can no longer work or support myself. I cannot eat the food that I enjoyed cooking. I cannot pray at the temple whenever I wish to. I am grateful to have this place to stay, but I sometimes miss Delhi. Leaving my home was a hard decision. (Prem, Personal interview. 23 June. 2008)*

In Prem's narrative, it begins to become clear that to some extent there is a mismatch between the personal power she derives from the having the freedom to work and cook her own food, and the current model of empowerment she faces in the ashram (which emphasizes safety). However, before dismissing *Ma-Dham's* structure as universally oppressive from an outsider's point of view, it is important to see what other women think of the ashram. When talking to older widows who are unable to cook or work, *Ma-dham* is a haven—the structure provides the support and empowerment they need to survive. This notion is evident in an interview with another widow in *Ma-Dham*, Menka:

*When I was younger I used be a dancer, a librarian, an artist, and a poet. Now look at me, I can barely wash my own hair, or cook my own food. I wish I could go back home. But at least here they give me food and money so that I can live in peace.*

This interview, while still expressing distaste with the structure of the ashram, also shows that in some ways the model of care and safety that *Ma-Dham* provides is necessary if the widow is unable to perform certain tasks in order to live a good life. What is



especially interesting to hear are the accounts of women who are not widowed, yet living among the widows in *Ma-Dham*. One example is Bharti, a young woman, age 26, for whom the ashram's model of empowerment was beneficial in some ways but not others:

*I came here because my heart condition was giving me trouble. I tried working and I did for many years, but I had to come here to rest. At least here I do not have to worry about earning money to get food and shelter. I want to be able to work and one day be a police officer, but I need to recover first.*

After gathering these interviews, I asked the founder of the *Ma-Dham*, Dr. Mohini Giri, what her definition of empowerment is. She replied that empowerment is "the absence of fear" (Giri M. Personal interview. 16 July 2008). According to her vision and definition of the term, the ashram accomplishes just that. Generally, it is not explicitly clear whether the ashram best serves an individual widow, but through interviewing her, one can better understand her needs and how the ashram can best facilitate them.

Conversely, another ashram, *Chetan Bihar*, prescribes a model of empowerment that emphasizes freedom over the safety of the widows. Structurally, the unguarded nature of the building, presented as an embedded segment of the city, allows a different set of options for the widows: the ability to work, cook, and leave at their own will. For a widow like Maya, *Chetan Bihar* was an ideal home after her husband passed away, and her two daughters were married:

*I really enjoy living here because it is better than a boarding house. At least here, I do not have to pay and nobody tells me what to do. [...] Everyday I go to the bhajanashrams and play the accordion and sing to Lord Krishna. [...] This is the best stage of my life. I liked being married; then when my husband died, I enjoyed raising my daughters. Now, I am alone, but I love it. I can do anything I want.* (Maya. Personal interview. 1 July. 2008)

For Maya, *Chetan Bihar's* model of empowerment mirrors her own sense of personal power and fit her needs. However, it is now clear that the ashram does not create a space that is empowering for women who would be unable to perform these tasks of basic sustenance. For example, Seema was not as satisfied with her life in *Chetan Bihar*:

*I am too old to go out and work in the city like many of these younger women do. I have trouble cooking so sometimes I just ask my roommate to cook for me. The people here are very nice, but it is hard for me to live here.*

In all, the assumption made by ashrams that the people they serve need to be empowered, is faulty on the basis that no distinction is made between various methods of facilitating the success of the women they serve: what kind of personal power and improvement are these women looking for, if any? Both *Chetan Bihar* and *Ma-dham* assume one view of empowerment for all the women (freedom and safety, respectively), regardless of their individual backgrounds. Therefore, a segment of their widows will always be affected negatively by the assumptions made by the ashram in their model of empowerment.

### Media Assignment of Empowerment

These various constructions of empowerment are largely shaped by the popular global views that distinguish between what it means to be oppressed and what it means to have power. Contributing to this occurrence is the sensationalization of widowhood in the media. Instead of allowing power to be determined by individuals, recent films and articles have designated all widows as a group who needs to be empowered, implying that they are at some point powerless. A closer examination of these popular beliefs reveals generalizations that are increasingly being adopted by the global community, leading to a phenomena that can be interpreted as a type of colonization targeted specifically towards Indian widows; one with positive intentions but dangerous consequences.

The BBC article "India's neglected widows"<sup>15</sup>, the CNN story "Shunned from society, widows flock to city to die,"<sup>16</sup> and the Indian Express piece "They flock to Vrindavan with the crushing weight of widowhood"<sup>17</sup> all emphasize the assumed tragedy of widowhood in a way that inevitably creates an Othering effect. The articles presume definitions of self-power that deemphasize individual experience in order to create a unified, enticing story. From phrases like "neglected," "shunned," "and "crushing weight of widowhood," the reader is made to associate pity, rather than understanding, with widowhood. The widows are uniformly represented as powerless, and seeking an

external savior.

The articles delve into statements about how the widows in Vrindavan are ostracized by society, unwanted by their families, and dejected by unforeseen life circumstances. While this may be true for many women, it is certainly not the case for every widow in Vrindavan. Nearly one quarter of the women I interviewed in the various ashrams were not widowed—they were simply posing as widows. The women ranged from being married, to divorced, to unmarried, to runaways from unsuccessful marriages. Bharti was a woman of 26 who ran away from her husband after being accused of cheating on him. Namita was a woman of 45 who decided that she could not live a life close to *bhagwan* (God) while remaining in the same house as her husband. Roshan was a woman in her seventies who never married. In fact, in *Chetan Bihar*, there were numerous women who had husbands and families, but lived in the ashram as a source of income and food to send back home. Essentially, there were as many stories as there were women in the ashrams. The main differences were the extent to which their external empowerment matched their personal needs. It seems that the degree to which the two complemented each other determined the happiness and satisfaction of the individual woman.

In essence, then, the problem in popular articles and movies like Deepa Metha's *Water*<sup>18</sup>, and Dharan Mandrayar's *White Rainbows*<sup>19</sup>, is the manner in which they disregard and homogenize individual experience. As outsiders to the issue, we approach the complex and indefinite nature of widowhood with a false sense of certainty and a preconceived system of beliefs. Furthermore, assigning a stagnant set of characteristics to a group of people, in this case widows, immediately makes them the Other. In fact, the various issues faced by widows in India are shared by individuals in the United States: for example, women undergoing domestic violence, and the aging population. However, the media largely presents the issues as specific to widows, making them seem powerless, and the surrounding community seem implacable.

## Conclusion

In all, I found that the vague sense in which the term *empowerment* was overused, led to a homogenization of widowhood experiences and narratives in northern India. This normalization led to

ineffective ashrams in the sense that they ignored the needs of the individual women and provided a blanket form of empowerment for all. For example, the model of freedom provided by *Chetan Bihar*, led to an inability for older widows who could not work to take care of themselves. I propose the need for widow ashrams in Northern India to look specifically at the needs of individual widows and either shape the resources in the ashram to better suit the women, or simply refer the women to an ashram that fits their needs more closely. Additionally, rather than handing down resources to the widows, there needs to be a shift towards working with the women and helping them accomplish their own self-identified goals.

## (Endnotes)

- 1 An ashram is a community formed for the personal, and often spiritual, uplifting of the people living within the group.
- 2 Sindoor is a red powder applied to either the forehead or the parting-line of a woman's hair when she is married. It signifies and distinguishes a currently married woman.
- 3 Zola, Emile. *The Laws of Manu*. Trans. Wendy Doniger O'Flaherty and Brian K. Smith. New York: Penguin Books, Limited, 1991.
- 4 A patrilocal system of marriage is one in which the woman, once married, moves to the house of her in-laws with her husband.
- 5 Brahmin is the highest caste in the Hindu caste system and includes teachers, scholars, and priests. The other castes, in order, include: Kshatriyas (warriors), Vaishyas (traders), and Shudras (agriculturists, laborers)
- 6 Chakravarti, Uma. "Wifhood, widowhood and adultery: Female sexuality, surveillance and the state in the 18th century Maharashtra." *Contributions to Indian Sociology* 29 (1995): 14.
- 7 *Ibid*, p. 16
- 8 Chakravarti, Uma. "Conceptualizing Brahmanical patriarchy in early India: Gender, caste, class, and state." *Economic and Political Weekly* 28 (1993): 579-85.
- 9 Chen, Martha Alter. *Perpetual Mourning : Widowhood in Rural India*. New York: Oxford UP India, 2001.
- 10 Sati is a practice of forced or voluntary widow-burning upon her husband's funeral pyre. The

practice was banned in 1829 but had to be banned again in 1956 after a post-colonial resurgence.

11 Bhajanashrams are temples that widows frequent twice a day to chant prayers and holy songs in order to earn two to three rupees and raw ingredients for cooking. Oftentimes, people will donate food, clothing, or blankets to these ashrams to distribute to the widows.

12 “The meaning of women’s empowerment: new concepts from action.” Harvard Series on Population and International Health (1994): 127-38. One Source. Stanford Green Library, Stanford.

13 Breton, Margot. “On the Meaning of Empowerment and Empowerment-Oriented Social Work Practice.” Social Work With Groups 17 (1994): 23-37.

14 Rocca, Corinne H. “Challenging assumptions about women’s empowerment: social and economic resources and domestic violence among young married women in urban South India.” Int. J. Epidemiol. (2008): 1-9

15 McGivering, Jill. “India’s Neglected Widows.” BBC 2 Feb. 2002. <[http://news.bbc.co.uk/2/hi/south\\_asia/1795564.stm](http://news.bbc.co.uk/2/hi/south_asia/1795564.stm)>.

16 Damon, Arwa. “Shunned from society, widows flock to city to die.” CNN 5 July 2007. <<http://www.cnn.com/2007/WORLD/asiapcf/07/05/damon.india.widows/index.html>>.

17 Gopinath, Vrinda. “They Flock to Vrindavan with the crushing weight of widowhood.” India Express 26 Feb. 2006.

18 Water. Dir. Deepa Mehta. Perf. Lisa Ray and John Abraham. DVD. 20th Century Fox, 2006.

19 White Rainbow. Dir. Dharan Mandrayar. Perf. R.S. Shivaji and Virendhra Saxena. DVD. Indican, 2007.

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# Economic Effects of the Spanish Conquest of the Philippines and Mercantile Theory

Pranav Merchant<sup>1</sup>

This paper seeks to examine the immediate economic effects (within the first 75 or so years) of the Spanish conquest of the Philippines in the mid-16th century. Additionally, this paper hopes to determine whether colonial Spanish rule in the Philippines was consistent with mercantilist theory by comparing the actual economic effects to what mercantile theory hypothesizes they should have been. By examining Chinese labor in the Philippines, understanding the scale and importance of the Philippine galleon trade, and looking at land use, this paper will highlight and explore the overarching economic effects of Spanish rule in the Philippines. The conclusions of the study are as follows: while the effects of Spanish conquest on land usage were limited, the conquest had an enormous effect on the use of Chinese labor and on the galleon trade. Furthermore, considering that the Philippines in all likelihood were not profitable for the Spaniards, this paper concludes that Spanish rule in the Philippines did not coincide with the predicted effects of mercantile theory.

## Preface

As it is, in the United States imperialism does not have as strong of an academic following as does European history or United States history. Furthermore, while curriculum and scholars on imperial history are most definitely present, they almost never focus on the early colonial Philippines, which seem utterly forgotten even in general discussions among both scholars and lay individuals. Such relegation to the virtual ash heap of scholarly and general research, debate, and discussion is severely unfortunate. Ignoring any area of history prevents people from obtaining a complete understanding of history in general, and ignoring the colonial Spanish Philippines—or Dutch Indonesia, Roman north Africa, Portuguese Mozambique, French Madagascar, or any other type of imperialism anywhere else in the world at any time in history—does not allow the imperial historian to obtain a fully accurate and complete understanding of imperialism as a general phenomenon. The lesser-known areas in the study of history in general and imperialism specifically

must receive their due and deserved attention. This paper hopes to provide this attention to the Spanish Philippines.

## Introduction: Mercantilism

Because this paper looks at the economic characteristics of the Spanish Philippines in the mercantile era and whether those characteristics coincide with mercantilist theory, it is essential to know the central traits of the mercantile system. Although each European power practiced mercantilism uniquely, historians have been able to discern its most defining features:

1) Centralization of state power. From the early to mid-16<sup>th</sup> century to the late 18<sup>th</sup> century, European states began to assume increasing responsibility in the administration of their societies. This centralizing tendency was accelerated by the fact that modern nations were forming. In Spain, for example, the three kingdoms of Castile, Aragon, and Navarre gradually united to form *Hispania*. This centralizing tendency had implications for the expansion of colonial rule: to fund their growth and military engagements within Europe, European states began the trend of colonial acquisition.

2) Tariffs and taxation. Emerging European nations, believing that wealth was limited and thus wanting to obtain as much of it as possible, sought to use their overseas colonies as sources of revenue. Europeans shaped their colonies' economies with the guiding belief that agriculture was the basis of wealth. While agricultural enterprises in colonies were run privately, the majority of the labor in the expanding empires was concentrated in agriculture and natural resource acquisition. As a result, European nations funded their growth by taxing the trade in raw materials extracted from their colonies. To obtain wealth for themselves and to prevent foreigners from obtaining wealth, nations also imposed tariffs on their colonies' overall trade. Because European nations saw wealth also in terms of precious metals such as gold and silver, so they established extensive networks to trade goods for these metals. As private trade flourished in these networks (often under the auspices of state chartered

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companies), the European nations intervened and collected taxes.

3) Royally chartered companies. Notable examples include the British East India Company or Dutch East India Company. Chartered companies had trade monopolies, granted by the crown, in areas such as slave trading or the transportation of certain goods.

As we shall see in our analysis, the traditional components of mercantilism fail to adequately characterize the Spanish Philippines.

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Despite a history of contact with the Philippine islands in the early 16<sup>th</sup> century, the Spanish did not conquer the islands until 1571, during an expedition led by explorer Miguel Lopez de Legazpi. Thereafter, the Philippines were administered by New Spain (also known as the Viceroyalty of Mexico) because of the latter's relative proximity to the islands, though effective Spanish control was limited to the island of Luzon, in the port city of Manila and the surrounding areas. From the very outset, the Philippines were uncharacteristic of other colonies of the period in that they did not maintain direct contact with its European colonizer. Nonetheless, the economic repercussions of the Spanish conquest were significant. The three most important economic trends of the Spanish Philippines during the mercantile era emerged within the first 75 years of the Spanish conquest: the introduction of Western notions of land tenure leading to the rise of landed estates, the rise and dominance of the galleon trade from Manila to Acapulco, and the quantitative and qualitative increase in Chinese immigration to the Philippines.

These trends reveal that the Spanish Philippines did not follow a traditional mercantilist route. The galleon trade did not involve the exchange of raw materials from the colony to the European country. Chinese immigrant labor in the Philippines was focused not on agriculture but on commerce. Agriculture was practiced minimally in the colony. Finally, it is even likely that the Philippines were not profitable for Spain. In sum, the Philippines were a most unusual colony for a European power to possess during the mercantile period because they did directly fit into the economic framework of the time.

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First and foremost, Spanish usage of Philippine land reveals that the colony, at least in terms of its

economic effects, was atypical of other mercantilist enterprises, for agriculture was practiced on a small scale. One of the most significant economic changes that resulted after arrival of the Spaniards, however, a change that was not atypical of European expansion, was a change in the land tenure system. In pre-Hispanic societies, land was owned and used communally, tilled in groups that were brought together by chieftains who administered the land. Upon their arrival, however, the Spanish "introduced [...] the notion of land ownership as opposed to land use, the concept that individuals and not merely groups could own land, that land itself was a source of wealth." In essence, they introduced private land tenure. As a result, those chieftains who once administered lands now owned them, with the cultivators under their control.<sup>1</sup> There was nothing abnormal about this pattern. Wherever European colonizers went, to varying degrees they tended to usurp indigenous cultural practices and replace them with their own.

The establishment of private land tenure not only changed Filipino land relations, but it also led to the private ownership of land by Spaniards, in turn leading to agricultural enterprise.<sup>2\*</sup> Although initially, at least, estates did not take on the importance they did in Spain's American colonies, their existence in the Philippines was still notable. From 1571 to 1626, the Spanish Crown made around 200 land grants, marking the initial growth phase of colonial estates. To make such grants, the Crown acquired land in the Philippines in one of two ways: Either it would assume ownership of land not inhabited by indigenous Filipinos, or it would purchase land from them.

By the time estates had become established in the 1620s, they ranged in size from 15 square miles to 60 square miles; this was a gargantuan area compared to the average of 0.037 square miles of land owned by native Filipino families. While the native inhabitants survived on small plots, the Church and private landholders received the bulk of land. Such massive landholdings allowed individual Spaniards and the Church to reap economic benefits from the leasing of lands, which they practiced widely, receiving anywhere from 25 to 75 pesos per year in rent by the early to mid-

1 John Leddy Phelan, *The Hispanization of the Philippines: Spanish Aims and Filipino Responses: 1565-1700* (Madison, 1959), 117.

2 \* The data on usage and agricultural enterprise that follows applies solely to the province of Tondo, near Manila.

17<sup>th</sup> century.<sup>3</sup>

Landed estates in the Philippines had two main uses: ranching and agriculture. In 1606, Manila had 24 cattle ranches. In 1615, one such ranch was valued at 6,500 pesos, an approximate value for the average worth of ranches during the first 50 to 75 years of Spanish rule. As early as 1659, however, ranches came into decreasing use in favor of agriculture, possibly because of the need to increase food supplies or because new Spanish immigrants began to focus less on the galleon trade. Most agricultural estates produced rice, although small amounts of land were dedicated to fruit, tobacco, and sugar. The average annual income of agricultural estates (farms and ranches) during the first 75 years of Spanish rule was about 2,300 pesos. Using a total of 24 cattle ranches, as mentioned above, Philippines cattle industry would have produced an annual income of only 55,200 pesos, and their total worth would only have been 156,000 pesos, indicating that agriculture was a small component of the Philippine economy.<sup>4</sup> Thus, in terms of agriculture, the Philippines were a mercantile oddity because farming and ranching produced little wealth in the colony.

In fact, private land holdings and the resulting attempts at agricultural enterprise were the exception to Spanish economic endeavors, not the norm. Interestingly, neither sustained the Philippines, as usual mercantilist practice would have dictated. As it turned out, until the mid-1700s,<sup>5</sup> the galleon trade

“discouraged Spaniards from tilling the soil, for by purchasing Chinese luxury items which arrived each year in Manila and shipping them to Acapulco for sale at the annual fair, Spaniards could reap high profits with a minimum of labor. Thus the galleon trade, not agriculture or cattle raising, became the principal source of wealth for Spaniards in the Philippines.”<sup>6</sup>

With respect to the role of agriculture, then, the Philippines did not follow a mercantilist path. Taking into consideration non-cattle ranches as well as cattle ranches and estates, Philippines agriculture and

3 Nicholas P. Cushner, *Landed Estates in the Colonial Philippines* (New Haven, 1976), 23-34.

4 *ibid*, 37-44

5 Paula De Vos, “A Taste for Spices,” *A Journal of Pacific Maritime History*, Vol. 41 No. 4 & 42, 1 (2005 & 2006), 3.

6 Cushner, 24

ranching produced only several hundred thousands pesos worth of income annually. This was a minimal amount and would not have allowed the Philippines to grow as it did.

\* \*

This leads us to the next significant economic effect of the Spanish conquest of the Philippines: the rise of the galleon trade, which, while being the very heart of Spain’s mercantile enterprise not only in the Philippines but also in Asia for over two centuries, did not coincide with traditional mercantile practice. At its core the galleon trade was simple: it linked China and Mexico through the Philippines. Spain was not directly involved, and the Philippines served only as a point of exchange for goods, not as a source of raw materials. Silver from the Americas would leave via Acapulco, on the southwestern coast of Mexico, headed for Manila. Goods, most notably silk, would leave via the southeastern coast of China, also headed for Manila. In Manila, the silver and the silk would exchange hands: the Chinese merchants would take silver back to China, while Spanish merchants would take Chinese goods back to Mexico.<sup>7</sup> High demand for silver in China and high demand for silk in Mexico were met, and neither the colonizing country nor raw materials were involved.

Almost immediately after arriving in 1571, Spaniards began to see the potential for trade with China. As a result, they made concerted efforts to establish good relations with Chinese merchants in the area. In its first 40 years the galleon trade grew quickly, unhindered by cumbersome restrictions. Commerce increased, bringing with it Chinese immigrants as well as merchants from all over Asia.<sup>8</sup> In its first decade the galleon trade was not taxed and took place at several ports in the Philippines. Although the Crown soon decreed that the trade would be taxed and could only take place in Manila, the galleon trade continued to grow, with Peru also becoming involved, trading silver for Chinese silks. By the early 1590s, a total of 12 million pesos had already been traded, and the trade was averaging 2 to 3 million pesos a year, most of which was headed for China. This expansion continued into the 17th century. By 1602, approximately 5 million

7 Martha N. and John Hoyt Williams, “The Route to Riches,” *Americas*, Nov.-Dec. 1984, 2.

8 Robert Ronald Reed, *Hispanic Urbanism in the Philippines: A Study of the Impact of Church and State* (Manila, 1967), 110. Hereafter, “Reed”

pesos per year were being shipped from the Americas for Chinese goods.<sup>9</sup> Throughout the 17<sup>th</sup> century, approximately 2 million pesos worth of goods were traded every year on average.<sup>10</sup> Clearly, the galleon trade dwarfed and supplanted Philippine agriculture as the foundation of the colony's economy, in contrast to other colonies of the time, in which trade complemented agriculture through the exchange by shipping of raw goods and finished products.

The rapid rise of the galleon trade caused significant alarm in Spain. One major concern was voiced by the Andalusian textile sector, which began to see falling textile prices as Chinese textiles flooded into the Americas. Ironically, the Philippines had created competition for the industries of Spain because of finished Chinese goods being traded through them. Colonies were supposed to support their "mother countries" and the industries of the mother countries; the Philippines threatened them. Another concern was the fact that so much silver was leaving Spanish hands. Contrary to what economic practice at the time dictated, the Philippines did not allow for wealth to be amassed. As a result of these concerns, the Crown instituted a number of regulations restricting the galleon trade. In 1593, it decreed that only two ships could be involved in the galleon trade every year, one from Manila to Acapulco and one on the opposite route. Additionally, Chinese goods sent from Manila to Acapulco could be valued at only 250,000 pesos and could be sold for a maximum of 500,000 pesos.<sup>11</sup> Moreover, in 1631 the Crown prohibited all trade between the Philippines and Peru.<sup>12</sup>

The patterns established and the regulations instituted in the first decades of the 17<sup>th</sup> century remained relatively unchanged through the 1600s. As average trade numbers for the 17<sup>th</sup> century reveal, however, actual trade significantly surpassed legally

9 Katharine Bjork, "The Link that Kept the Philippines Spanish: Mexican Merchant Interests in the Manila Trade, 1571-1815," *Journal of World History*, spring 1998, 18. Hereafter "Bjork."

10 Dennis O. Flynn and Arturo Giraldez, "Spanish Profitability in the Pacific: The Philippines in the sixteenth and seventeenth centuries," *Pacific Centuries: Pacific and Pacific Rim history since the sixteenth century*, ed. Dennis O. Flynn, Lionel Frost, and A. J. H. Latham (New York, 1999), 27. Hereafter "Flynn."

11 Marciano R. De Borja, *Basques in the Philippines* (Las Vegas, 2005), 60. Hereafter "De Borja."

12 Bjork 19

permitted trade. Importantly, though, the Philippines did not satisfy traditional mercantile goals. During the mercantilist era, European nations were acquiring colonies in order to gather wealth for themselves, but through the Philippines, wealth was leaving Spain and Mexico for foreign hands.

Indeed, the galleon trade in the Philippines was in stark contrast to what mercantile theory would have predicted. Although goods and silver flowed between Mexico and China through the Philippines, the trade did not involve raw materials being extracted from the colony in order to be exchanged for finished products from the colonizing country. The colony only acted as a point of exchange for goods and not as a source of resources, and the mother country was not even directly involved in the trade.

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The economic effects of the Spanish conquest did not parallel normal mercantile practice because of the nature of the increase in Chinese immigration to the Philippines as well, for the massive amounts of Chinese labor that arrived after the Spaniards focused not on agriculture but on the galleon trade.

Because of the proximity of China and the Philippines to one another, the Chinese and the Filipinos had had some commercial contact through passing Chinese junks even before the Spanish arrived. When the Spaniards conquered the islands in 1571, 150 Chinese settlers had already established themselves there.<sup>13</sup> The arrival of the Spanish, however, changed all of that. For the Chinese, the arrival of the Spanish meant economic opportunity vis-à-vis the galleon trade. Consequently, in the first few decades after 1571, the Chinese population in the Philippines grew rapidly. By 1586, there were around 10,000 Chinese in the Philippines. In 1603, when anti-Chinese violence erupted, 20,000 were *killed*; by 1621 the Chinese population had increased back to 20,000,<sup>14</sup> revealing its resiliency—and hinting at its importance.

Indeed, the Chinese were crucial to the survival of the colonial Philippine economy. Chinese laborers served many functions in Philippine society, and their labor was not limited to any one field but spanned positions of "fishermen, gardeners, hunters, weavers,

13 Edgar Wickberg, *The Chinese in Philippine Life: 1850-1898* (New Haven, 1965), 3-4. Hereafter "Wickberg."

14 Henry Kamen, *Spain's Road to Empire: The Making of a World Power, 1492-1763* (New York, 2002), 207-8. Hereafter "Kamen."

brickmakers, lime-burners, carpenters, iron-workers, tailors, cobblers, bakers, meat-vendors, candle-makers, confectioners, painters, apothecaries, silversmiths, food-peddlers, [...] silk merchants [,] sculptors, locksmiths, and masons.”<sup>15</sup> In addition, the Chinese performed another vital function: they housed the physical trading that ran the colony through the galleon trade. For the first several decades after the arrival of the Spanish, the Chinese were limited to Manila. Moreover, they were segregated in an area known as the Parian. It was in the Parian, under the auspices of the Chinese, where goods were exchanged for silver. Furthermore, while Chinese merchants from the mainland were responsible for bringing the goods, the Chinese in the Philippines were responsible for packing the goods into ships headed to Mexico. The Chinese were crucial to the business of packing goods, inherently a very important task. Since the Spanish Crown limited the amount of trade that could take place between China and Mexico, the Chinese packers shrewdly packed goods in such a way as to exceed the limits set by the Crown.<sup>16</sup>

The Chinese faced antipathy from the Spanish and the Filipinos, who viewed Chinese economic pervasiveness and success with jealousy. Despite the fact that the Chinese “filled occupations which the Spaniards scorned and for which the [Filipinos] were believed unsuited,”<sup>17</sup> the Chinese faced sporadic violence from the Spanish and even from the Filipinos, who were, as one historian phrased it, “always willing to get rid of” the “fundamentally peaceful” Chinese.<sup>18</sup> In 1603, Spanish authorities, with the direct assistance of indigenous Filipinos, suppressed a Chinese insurrection by murdering 24,000 Chinese inhabitants—almost the entire Chinese population in the Philippines. In response to a Chinese rebellion in 1610, the Chinese population of Manila was segregated in the Parian. In 1639, when the Chinese rose up against Spanish repression, another 23,000 were killed.<sup>19</sup> So crucial were the Chinese to the galleon trade, however, that the 1603 massacre led to an economic depression in the island, halting all trade for one year. Indeed, whenever the Chinese were killed in large numbers after revolting, the colony underwent economic stagnation, since no one was willing or able

to do the fundamental work that only the Chinese performed.<sup>20</sup>

Chinese immigrants were the backbone of the Philippine economy, but because the latter was based on the galleon trade and not agriculture, Chinese labor was centered in commerce and trade. This was in contrast to what mercantilist theory would predict. Since European nations wanted to use their colonies as sources of raw materials, labor in other colonies would have been concentrated in agriculture. As the case of the Chinese reveals, this was not the case in the Philippines, for the Philippines predominantly acted as a location for trade, not a source of raw materials.

\* \*

Finally, in determining whether or not the Philippines fit the mercantile mold, it is useful to see what economic effect the conquest had on the Spanish crown itself, since the purpose of colonial acquisition was to make a profit. Was keeping the Philippines profitable, at least in the short term of the first 75 years after acquisition? The usual answer to this question has been a resounding “No.” Most scholars have argued that the Philippines did not produce enough revenue to provide the Crown a surplus and only drained the Crown’s coffers with high administrative expenses. In addition, trade restrictions prevented the galleon trade from providing substantial tax revenue. Some recent historians, however, have argued that the Philippines did provide profit for the Crown. Based on the average of 2 million pesos per year for galleon trade, the Philippines are approximated to have provided around 218,000 pesos per year in profit. The scholars proposing this number have called it “tentative,” however, because they arbitrarily estimated the gross benefit of the galleon trade to the crown.<sup>21</sup> As a result, it is safer to follow the traditional, thoroughly argued conclusion that the colony was not profitable. Thus, in yet another way, the Philippines were an unusual mercantile colony. Even though the ultimate goal of the Spanish crown, in accordance with obvious economic norms, was to maximize its profit, it was willing to sustain losses in order to retain the Philippines.

### Conclusion: A Mercantile Anomaly

Examining the first 75 years of Spanish rule in the Philippines without looking at how that rule fits

15 Reed 137  
16 *ibid* 131-2  
17 Wickberg, 8  
18 Kamen, 208  
19 De Borja, 77

20 Reed, 132 & 138  
21 Flynn, 25-31



into a general description of mercantilism would be incomplete. Judging from the economic ramifications of Spanish acquisition, it becomes clear that general mercantile theory only partially describes the Spanish Philippines. In the first 75 years, the centralizing Spanish state did attempt to limit the galleon trade and even encouraging agriculture. But it was not successful, as the galleon trade's 200+ year life span suggests. Thus, while in theory the colony of the Philippines was supposed to allow the Spanish Crown to accumulate as much wealth as possible through agriculture, in practice the exact reverse occurred. The galleon trade not only caused silver to leave Spanish hands through trade with the Chinese and through smuggling (which meant that the Crown collected less tax revenues, the maximization of which was a key feature of mercantilism), but it also prevented agriculture from flourishing because trade was so profitable. Spaniards had no incentive to leave the galleon trade to farm or ranch, for they would have made less money doing so. In addition, by attracting capital as well as labor from agricultural enterprise, the galleon trade morphed the traditional mercantile relations between European nation and its colony. The Philippines provided Spain not with indigenous raw materials but with finished goods from China. Moreover, private traders from China and from Mexico ran the galleon trade; Spain issued no royal charters for monopoly companies for the Philippines, unlike in many other colonies, in which charter companies dominated. As a result, the Philippines stand out as a colonial anomaly. Isolated from Spain; they did not follow a traditional mercantilist path. The Philippines do not fit well into traditional mercantile theory.

### Afterword

So what does Spanish imperialism in the Philippines during the mercantile era say about mercantile imperialism in general if the Philippines did not meet Spain's mercantile goals yet Spain still chose to retain them?

The significance of the Spanish Philippines in relation to mercantile theory is twofold. First, it reveals that when examining the mercantile empires, non-economic factors need to be given equal consideration relative to economic factors. The case of the Spanish Philippines is such that economics may not have been the main reason for keeping the colony. As some historians have suggested, religious or strategic reasons may have

been more important.<sup>22\*</sup> Some assert that Spain kept the Philippines with the hope of spreading Christianity into China, while others argue that the Philippines' central location in the Pacific, near the colonies of other European powers, gave Spain a naval advantage.

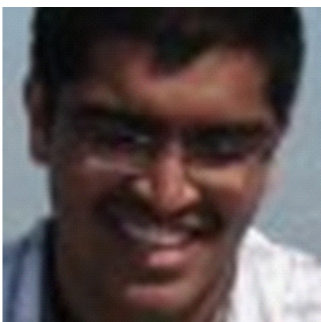
Secondly, and just as notably, the example of the Spanish Philippines reveals that the broad characteristics scholars have used to describe mercantile empires do not always provide an accurate picture of every colony in the mercantile era. Mercantile "theory" is indeed not a coherent set of principles that can be applied to every situation with absolute certainty. For example, as the weakness of agriculture in the Philippines reveals, colonial economies did not always operate according to the general archetype proposed by scholars: it was a major source of neither agricultural goods nor commodities. Ultimately, the Spanish Philippines show that mercantile theory needs to be applied carefully when evaluating European colonies during the mercantile period.

Acknowledgements: Michael Wernecke and Colin Gray, and Antony Hopkins.

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# Surviving Predation: multi-species grouping is a defense strategy for 3 sympatric Batoids in Heron Island, Australia

Gen Del Raye<sup>1</sup>

Multi-species groups are potentially mutualistic interactions that have garnered relatively little scientific attention. This study examines three batoids (skates and rays), *Dasyatis thetidis*, *Pastinachus sephen*, and *Rhinobatos typus* that regularly form resting aggregations in the intertidal sand flats of Heron Island, Australia. The defensive role of these aggregations is assessed with the aim of evaluating two questions. 1: How does predation risk affect the decision to form groups? And 2: Are mixed species groups more advantageous than single species groups? All three species responded to increased predation risk as represented by either a smaller body size or by higher tidal height by forming larger and more numerous groups. In addition, all three species showed a significant preference for mixed species groups over single species groups. This data strongly suggests that resting aggregations serve a defensive purpose, and that this may be a novel example of mutualism between batoids.

## Introduction

The influence of predators on the behavior of their prey has received increasing attention in recent years as the technology for tracking and understanding predator movement improves<sup>1,2,3</sup>. One of the best-studied behaviors elicited by predators on their prey is grouping<sup>4,5,6</sup>. Fish form groups or schools in conditions of high predation risk due to a number of potential factors: (1) increased vigilance, (2) cooperative defense of the group, (3) confusing visual cues sent to the predator in a coordinated flight, (4) the dilution effect where any single predator is only able to consume a limited proportion of a large group, and (5) the Trafalgar effect, where if the presence of a predator is signaled across a group at a speed greater than the predator's approach, individuals on the far side of the group are able to gain an early warning<sup>7</sup>. However, there are also significant costs to grouping, which are related to increased resource competition, agonistic interactions between group members, and increased disease transmission. That the negative effects can often outweigh the benefits of

grouping is evident in the fact that many species group facultatively, forming dense aggregations under some conditions but remaining solitary under others<sup>8</sup>. Multi-species groups are a special case of the predator-induced group, where additional benefits may be provided by the aggregation of a mix of species. First, the disparate sensory capabilities of the different species can provide a more complete predator detection system for the group as a whole. Second, predator preference for one species or another can "enhance" the dilution effect for the remaining species because the potential predator is more likely upon being presented with a number of prey choices to target only the preferred species. Thus, mixed-species grouping, if it occurs as a consistent behavior, is often an important aspect of commensal or mutualistic symbiosis<sup>9</sup>. The influence of predation risk on inducing the formation of multi-species groups is a topic that has so far been little studied.

Semeniuk and Dill investigated the multi-species grouping of cowtail rays (*Pastinachus sephen*) and whiplays (*Himantura uarnak*) in Shark Bay, Western Australia<sup>9</sup>. They found that in this system, the presence of whiplays within groups of the more common cowtail rays increased the detection distance of the group as a whole to a simulated predator approach. Following single cowtail rays across the sand flats revealed that roaming cowtails were also significantly more likely to settle next to a whiplay than to a conspecific. However, no investigation of whiplay preference was made to assess the potential role of cowtails in mixed species groups. Similarly, a subsequent paper investigated the function of the facultative grouping of resting cowtails in single-species groups and concluded that grouping appeared to serve primarily to decrease predation risk<sup>7</sup>. However, the influence of specific physical characteristics of the rays themselves in influencing the likelihood of grouping was not addressed.

The shallow sand flats of Heron Island provide an ideal environment for investigating the role of grouping as an anti-predation strategy in batoids. As in the Western Australian sand flats investigated by Semeniuk and Dill, the rays appear to form groups exclusively to rest. This allows me to focus on the possible defensive function of grouping without potential confounding

<sup>1</sup>Stanford University

factors such as prey distribution and abundance. Similarly, the protected nature of the shallow bay well within an extensive fringing reef system makes it unlikely that current or wave energy are significant factors in group formation. Finally, the influence of the tides on the faunal composition of the site allowed tidal height to serve as an effective proxy for predation pressure. During the low tide, much of the sand flat and adjacent reef flat is exposed to air, forcing all large animals out of the site. However, skates and rays are well adapted to taking advantage of the rising tides and previous observations suggested that they are nearly without exception the first large fish to enter the sand flats. As the tide rises further however, other animals such as turtles, benthopelagic rays, and large sharks are able to cross the reef crest and enter the sand flats. This transforms what is effectively a refugia for batoids early in the tidal cycle into a resting spot that involves distinct predation risk. This system is similar to many shallow sand flat ecosystems, and parallels closely the findings of Kerford et al on the predation pressure experienced by foraging bar-bellied sea snakes from tiger sharks while foraging on shallow sand flats<sup>2</sup>. In Heron Island, the simultaneous exposure of three sympatric batoids to this predation risk provides the unique opportunity to study the complex behavioral choices involved in the formation and dispersal of multi-species aggregations.

## Methods

### Study site and study species

Heron Island is a small coral cay located 60km offshore of Gladstone, Australia, in the southern Great Barrier Reef. It is formed by the western end of a large fringing reef system. The specific site chosen for study was a small sandy lagoon known as Shark Bay located on the southeastern tip of the island. The bay is bordered on the western side by a natural rock wall that forms the deep-water end of a short channel at high water. The area is well known for the numerous skates and rays that enter the bay on the flood tide. Three species in particular make up the majority of the batoids found here, the black stingray *Dasyatis thetidis*, the cowtail ray *Pastinachus sephen*, and the giant shovelnose ray *Rhinobatos typus*. All three species are generalized benthic foragers that use jets of water to sift through the sandy substrate and capture a variety of molluscs, crustaceans, and polychaete worms<sup>10</sup>. These three batoids form multi-species resting aggregations exclusively

with each other within the study site. Observations from the shore as well as pilot transects showed that these skates and rays are distributed predominantly in a band of very shallow water (0.5 to 1.0 meters of depth) along the beach and up to the rock wall. Often, there were also scattered individuals and small groups located near the sand to coral-rubble ecotone at 2-3 meters of depth. During the highest tides, the distance between this ecotone and the beach was about 50 meters. Other large animals regularly seen on the site include green sea turtles (*Chelonia mydas*), eagle rays (*Myliobatidae*), lemon sharks (*Negaprion brevirostris*), blacktip reef sharks (*Carcharhinus melanopterus*), and large schools of over 300 trevally, kingfish, snapper, and mullet.



**Fig. 1:** Aerial photograph of Heron Island showing Heron Reef in the center and the eastern end of Wistari reef on the left.

### The characteristics of grouping behavior

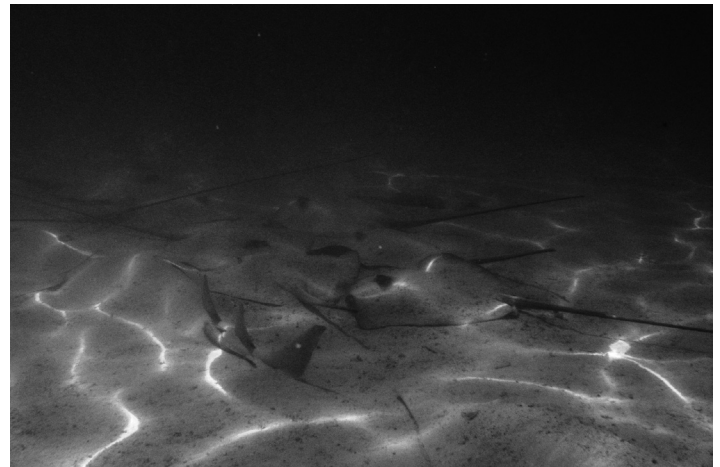
A rectangular transect was demarcated along an approximately 100m section of the coast. The transect included two major areas of batoid abundance. The first of these followed the 1-meter depth contour down the beach to the rock wall. This depth was chosen because while it represented the deep extreme of dense batoid distribution it was also within sight underwater of the exposed beach. Second, the sand to coral rubble ecotone was also surveyed in the reverse direction over the same distance of the beach. During the transect, the size and species of ray was marked down on a map of the study site printed on waterproof paper. Total length, estimated by eye, was used instead of disk width as a measure of ray size in an attempt to minimize the degree of uncertainty. Because total length is normally a much larger measure than disk width, it was assumed that random errors in size estimation for total length would

be proportionally less significant than the same errors in disk width, potentially minimizing the effect of bad size estimation on the data. Also, total length rather than disc diameter was preferred because it offered a measure for easy comparison of sizes across species. This was important because the giant shovelnose ray, *R. typus*, has an elongated body form for which disc diameter is difficult to define. Symbols were used to mark the orientation, approximate position, and state of movement (resting or moving) of the rays to record the spatial relationship between rays. This allowed us to note the occurrence of anti-predator “rosette” style resting formations<sup>11</sup>, as well as to measure group size and composition. “Grouped” rays were defined as sets of more than two rays situated with their disks or tails placed within 1 meter of each other. This distance was chosen as the approximate maximum distance of a ray’s bioelectric detection, which is one way in which predator detection could be communicated through a group. Direct tactile signals sent through the body disk or through the tail are another possible method of communication<sup>7</sup>. Therefore, instances of disk overlap or tail touching were also recorded. Feeding events - defined as a ray actively and repeatedly digging into the sand with its mouth - were noted on the map. Finally, the occurrence of potential predators such as tiger sharks, lemon sharks and blacktip reef sharks, as well as potential food items for these predators, such as eagle rays, sea turtles, and large teleost fishes, were recorded. The transects were performed hourly over a five hour interval beginning three hours before the high tide and extending to one hour after the high tide. The start time was chosen based on a pilot study that suggested that the first rays entered the beach area between three and four hours before the high tide. The transects were continued into the falling tide so that not only the rising tide but also the ebb tide could be used to infer a correlation between the data and the tidal cycle. The frequency of transects was chosen to be high enough to describe the progressive change in ray behavior at various tidal stages, but low enough to minimize pseudoreplication. The frequency of movement among rays and the significant changes in the number of rays between transects indicates that this was indeed the case. Transects were performed daily over three consecutive days from the 21<sup>st</sup> to the 23<sup>rd</sup> of December. On the final day, only four transects rather than five were performed due to time constraints. Tidal

ranges during the period of study ranged from 0.6m to 2.6m above the tide datum.

Simple statistical tests of significance, including Student’s t-tests (unpaired, two-tailed) corrected where necessary for multiple comparisons by the Dunn-Sidak method, Chi-square tests, and linear regressions were used to analyze the data for statistical significance.

**Fig. 2:** A typical resting group. Notice the presence of two species of batoids - the black stingrays in the center of the image and the giant shovelnose ray on the bottom left. The four black stingrays in the center are forming a loose rosette, where their heads are pointed into the center of the rosette and their tails, sensitive to water vibrations, are facing out. Notice also the disk overlap between the rays in the rosette and the tail overlap between leftmost ray of the rosette and a peripheral ray. The image has been converted to grayscale to clarify the outlines of the rays in the sand.



## Results

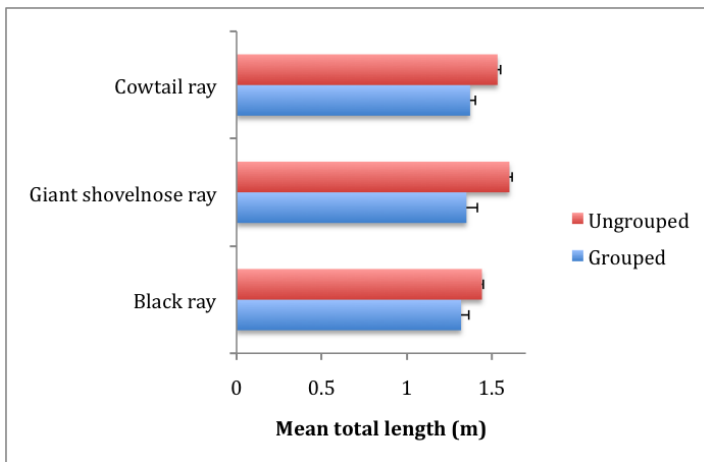
A total of 604 complete observations on the study subjects were made over the 3-day period. Mean total lengths of the rays for cowtail rays, black rays, and shovelnose rays was 1.45m (range 1.1-2.1m, SD=0.18), 1.34m (range 0.8-2.0m, SD=0.17) and 1.40m (range 1.2-2.1m, SD=0.23), respectively. The majority of the rays sighted were stationary on the substrate and assumed to be resting, although some were actively traveling and 3 cowtail rays were observed in the process of foraging. Groups of rays were commonly found in the previously described defensive “rosette” formation, although the percentage of these groups was not quantified.

81.9% of all the rays observed were found in groups. A one-way Chi-squared test with the expected frequency of grouping set at 50% found the preference for groups to be significantly different from chance (2 degrees of freedom,  $P < 0.0001$ ). 64% of the resting groups observed were composed of two or more species. A Chi-squared test using the numbers of rays

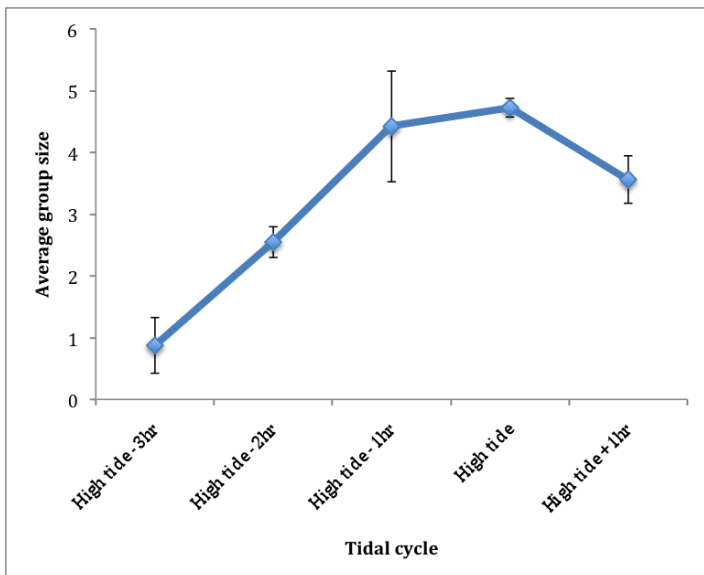
of different species observed to calculate the probability of mix group forming under random chance found the frequency of mixed species grouping to be significant to  $P=0.014$ .

### The effect of ray size on grouping

Grouped rays were significantly larger than ungrouped rays for all three species (2-tailed, unpaired Student's t-test). P values for the black stingrays, giant shovelnose rays, and the cowtail rays were 0.001, 0.002, and less than 0.0001 respectively.



**Fig. 3:** Differences in total length between grouped and ungrouped rays in the three batoids. All comparisons within species are significant to  $P<0.005$ .



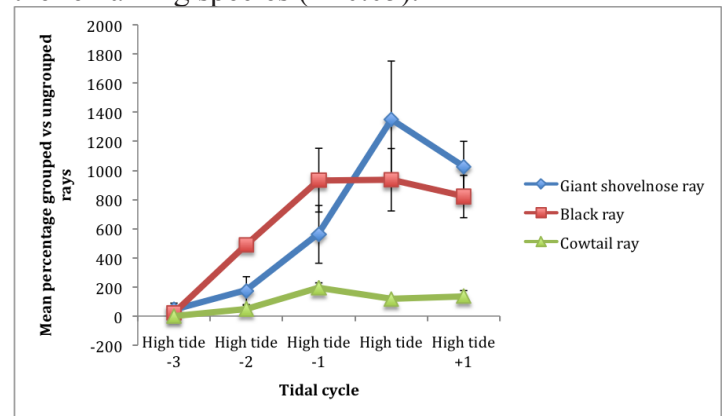
**Fig. 4:** Change in mean proportion of grouped versus ungrouped rays against a five-hour tidal progression.

### Changes in grouping behavior with the tide

The average group size appeared to correlate

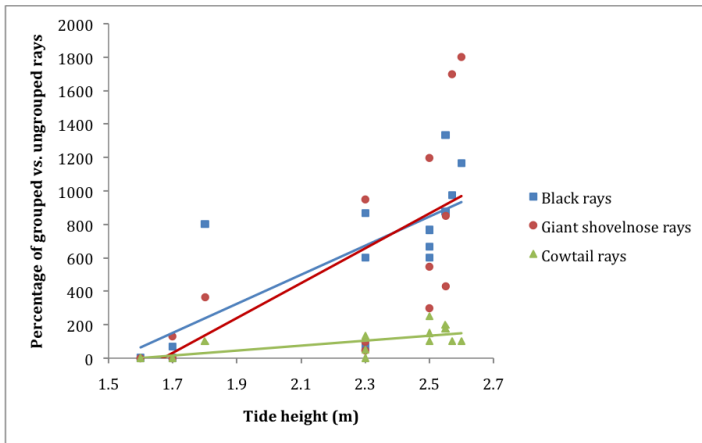
strongly with the tides. Mean group size of all species increased as the tide rose, reaching a plateau at high tide, and fell as the tide began to ebb.

The number of grouped versus ungrouped rays followed a similar pattern across species. Cowtail rays, however, showed a lower frequency of grouping overall than did the other two species. Cowtails grouped 49.2% of the time, giant shovelnose rays 85.8% of the time, and black rays 86.3% of the time. Unpaired t-tests adjusted for multiple comparisons by the Dunn-Sidak adjustment found a significant difference between the frequency of cowtail grouping compared to either of the remaining species ( $P<0.05$ ).



**Fig. 5:** Change in proportion of grouped versus ungrouped rays graphed separately for the three batoids against a five-hour tidal progression.

A rudimentary measure of covariance was obtained by graphing the proportion of grouped versus ungrouped rays against changes in the tide. In this case the tide height was considered independent of whether the tide was rising or falling. The trend observed was then tested for significance using a simple linear regression. Slopes for the relationship were significant for all three study-species ( $P<0.01$ ). Cowtail rays were significantly less responsive to tide height than the other two species ( $P<0.05$ ).



**Fig. 6:** Change in proportion of grouped versus ungrouped rays graphed against tidal height. All slopes significant to  $P < 0.01$ . The relationship between cowtail groups and tidal height is significantly different from the other two species by  $P < 0.05$ .

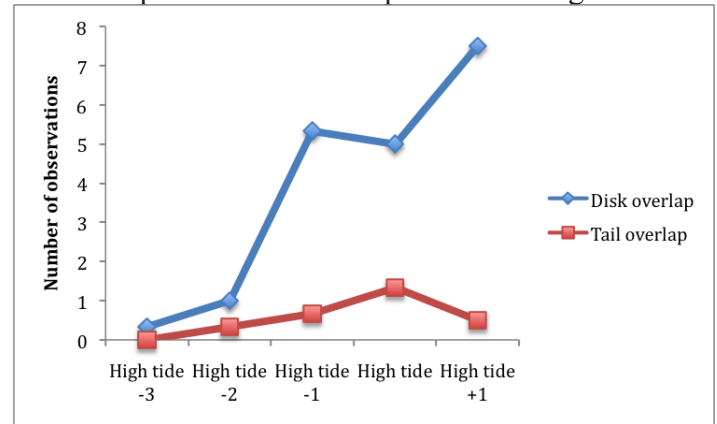
### Other relevant behaviors

Three separate feeding events were observed in the span of the study. In all cases, the feeding ray was a solitary cowtail ray and the event took place between two and three hours before the high tide.



**Fig. 7:** Photograph of a feeding cowtail ray. The excavations of the ray into the sand are sending up a plume of dust around it. A small fish hovers over the ray, foraging for scraps.

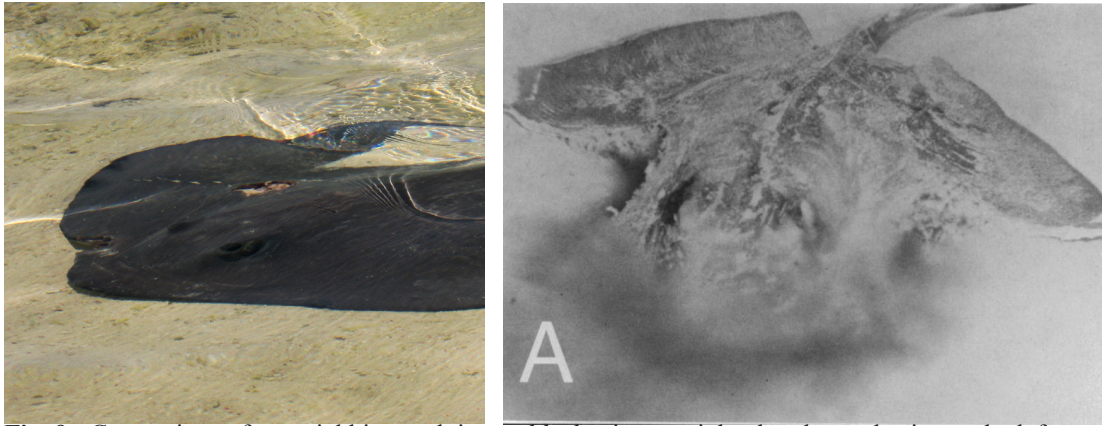
Disk overlap was much more common than tail overlap, with a total of 45 instances of disk overlap and 8 instances of tail overlap. Both tail and disk overlap showed a positive relationship with tide height.



**Fig. 8:** Mean frequency of disk and tail overlaps over a five-hour tidal progression.

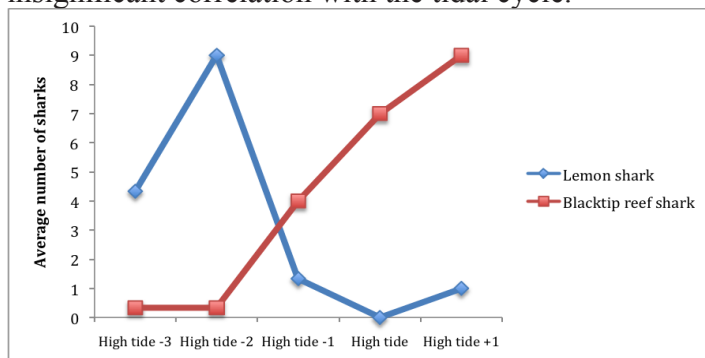
### Evidence of predation

I observed multiple potential predators of the study subjects in the area. Large lemon sharks over 2 meters long were seen in the eastern end of the transect. Tiger sharks are occasionally seen at the site (J. Roff 2008, pers. comm., 10 Dec.), and one approximately 9 foot juvenile was sighted just off of the end of the rock wall at high tide one day prior to the study. Solitary hammerheads (species unknown) have been sighted during the high tide on rare occasions in the vicinity of shark bay (S. Ward 2008, pers. comm., 10 Dec.), although none were seen during the duration of this study. Additionally, one injured black stingray was observed on the 22<sup>nd</sup> of December. The ray was the first to be sighted at the study site on the rising tide, and was subsequently re-sighted at the landward edge of a large group of 11 rays in less than 30cm of water. The ray had a crescent-shaped bite mark its right pectoral fin. The placement and orientation of the putative bite was very similar to that observed by Strong et al of a great hammerhead (*Sphyrna mokarran*) attack on a Southern Stingray (*Dasyatis Americana*), which stretched from near the rostrum of the ray across almost the whole front side of the pectoral fins<sup>12</sup>. In the observations of Strong et al, it was postulated that the very specific placement of the two sub-lethal bites by the shark on its victim was probably a behavioral adaptation to efficiently immobilize the ray, which may be a generalized hunting tactic for hammerheads in general.

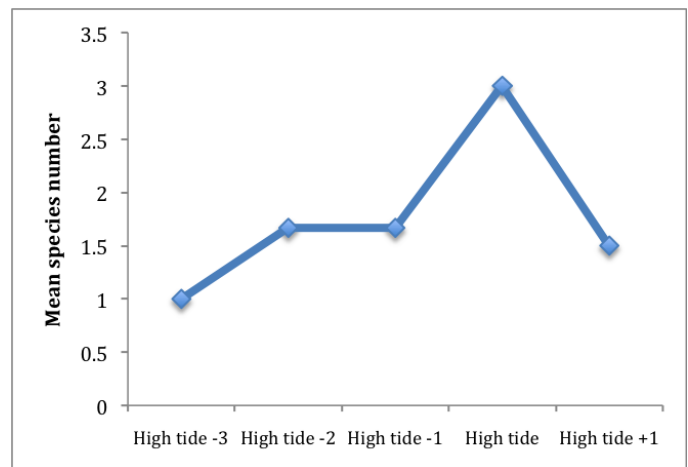


**Fig. 9:** Comparison of a partial bite mark in one black stingray sighted at the study site on the left to the bite marks inflicted by a ca. 3-meter great hammerhead shark (*Sphyrna mokarran*) on a southern stingray (*Dasyatis Americana*) just prior to consuming it (taken from Strong et al, 1990) on the right.

Additionally, the two species of sharks that were consistently sighted during the study, the lemon shark (*Negaprion brevirostris*) and the blacktip reef shark (*Carcharhinus melanopterus*) showed a clear pattern of distribution with respect to the tidal cycle. Lemon sharks (n=46), which appeared to be able to remain in the reef flat throughout most of the tidal cycle, displayed an early peak in abundance. In contrast, blacktip reef sharks (n=39), which were commonly seen aggregated in high densities outside of the reef flat at low tide and needed to cross the reef crest to re-enter the reef flat, showed a later peak in abundance. The number of potential prey species for large sharks, which in this study included adult green sea turtles (n=6), eagle rays (n=2) and large teleosts such as kingfish, trevally, mullet, and snapper, showed a distinct, but statistically insignificant correlation with the tidal cycle.



**Fig. 10:** Mean change in abundance of two shark species (blacktip reef shark, lemon shark) over a 5-hour progression of the tidal cycle.



**Fig. 11:** Change in the number of available prey species for large sharks in shark bay over a 5-hour tidal progression.

## Discussion

### Predation pressures in Shark Bay, Heron Island

One prominent assumption made in this study was the assumption that predation pressure in shark bay is significant enough to influence a major behavioral trait expressed by the batoids that rest there. Because predation events on rays are rare and difficult to observe, this must remain an assumption. However, this is a reasonable assumption given the following evidence: First, the crescent-shaped bite mark observed on the anterior portion of the pectoral fin in one black ray during the study period suggests that predation by large sharks on batoids is occurring in the vicinity of Shark Bay. Second, large sharks such as hammerheads, tiger sharks, and adult lemon sharks have previously been observed in the study site or in its immediate vicinity. Of these, various species of hammerheads are



particularly notable as being specialized predators of rays<sup>13</sup>. Finally, three lines of evidence suggest that tide level is the dominant factor influencing predation risk. First, previous research suggests that the distribution of large sharks in the shallow or intertidal zones is strongly affected by tidal height<sup>2</sup>. Second, patterns in the diversity of prey items in Shark Bay and the abundance of sharks such as blacktip reef sharks that are known to leave the bay during the low tide and reenter at high tide are both positively correlated with the tide. Third, the frequency of behaviors such as disk and tail overlaps, which are thought to be anti-predator behaviors, rises with increasing tide height<sup>7</sup>.

### Grouping as a response to predation pressure

This study provides support for the theory that the resting aggregations of rays serve an anti-predator function. In particular, grouping was shown to be a major response among all three species of batoids to increased predation risk. First, increased risk to individuals was an important factor in the decision to form a group. Smaller rays, which are likely to be more at risk to predation from large sharks, were significantly more likely to form groups than larger rays. Second, the general increase in risk also played an important role. The rise of the tide elicited a stronger grouping response in the rays across all species and across all three days. Finally, the spatial relationship between grouped rays showed strong, if not statistically significant, changes with the tide in the following ways. The formation of groups in defensive rosettes was noted frequently throughout the observation period. Also, behaviors such as tail and disk overlaps, which function to increase the speed of communication between rays was found to increase with tidal height, probably as a way of triggering a coordinated flee response in the event of a predator's approach.

The data collected makes a novel contribution to the literature by showing that two species that had not previously undergone this line of research, the black stingray (*D. thetidis*) and the giant shovelnose ray (*R. typus*), participate in grouping as an anti-predation behavior.

### Preference for mixed species groups

The significant trend towards mixed species groups suggests that the three batoids under study do preferentially form mixed groups over single species

groups. Unlike the study on whiprays and cowtails by Semeniuk and Dill<sup>9</sup>, no significant preference of any single species was found for another. The defensive advantage derived from mixed species groups are most likely due to differences in sensory capabilities among the three species involved. Although this was not explored in the research conducted above, there are strong reasons to expect significant differences in sensory systems among the species under study. McComb and Kajiura compared the visual capability of four batoids including the clearnose skate *Raja eglanteria* and the Atlantic stingray *Dasyatis sabina*<sup>14</sup>. These batoids showed large differences in size of the posterior blind spot as well as in the degree of binocular overlap. The skate had the most restricted visual field, with a 28° anterior binocular overlap, 8° of dorsal binocular vision, and a 16° posterior blind spot. In contrast, the Atlantic stingray had a more forward-oriented visual field with 72° of anterior binocular overlap, 20° of dorsal binocular vision, and a 34° posterior blind spot. A comparable scale of sensory disparity can be expected in the three study species, especially considering the large taxonomic differences between them.

The three batoids under study are a novel example of mixed-species grouping as a possibly mutualistic interaction in the coral reef environment. In this mutualism, the participation of multiple species in resting aggregations may heighten the defensive function of the group and minimize predation risk for all group members. Although the role of each species in the interaction needs to undergo further research, the results of this study are nevertheless a small indication that this type of mutualism may be more prevalent on the reef than is presently recognized.

### Differences between species

While the response of black stingrays and giant shovelnose rays to tidal height were similar, cowtail rays were found to be significantly less sensitive to tidal height than the other two species, and additionally were significantly less prone to forming groups. This is in contrast to the findings of Semeniuk and Dill, where cowtails were found to form multi-species groups more readily than whiprays<sup>9</sup>. This may be due to a variety of reasons. First, cowtails were the smaller of the two species in the former study while in the present one cowtails were the largest, although differences in the length measure used (total length versus disc diameter)

potentially confuses any comparisons. If the relatively larger size of cowtails, and therefore their decreased vulnerability to predation, accounts for the reluctance of this species to form groups in our study, then this is significant because it suggests that a general pattern of behavior may govern the formation of multi-species groups among rays. Rather than there being a preference of cowtails for whiplays as suggested by Semeniuk and Dill, a broader preference of smaller species for forming groups with larger rays may influence the behavioral decision to initiate group formation. This is further supported by the lack of clear preference of any species for another in the present study, which contradicts the species-specific preference for grouping found in cowtails by Semeniuk and Dill. However, this conclusion is confounded by the existence of a viable alternative explanation. This alternative holds that because cowtails were the only rays observed to forage during this study, the reluctance to enter into groups in cowtails may be linked to the need to feed. If the three instances of foraging observed during this study are indicative of a significant behavioral mode, then the cowtails could be expected to suffer two additional costs in grouping that are not experienced by the other species. First, grouping entails a heightened risk of resource competition that, if the prey source was limited, could discourage cowtails from forming groups. Second, foraging cowtails would potentially be affected more strongly in their distribution by the abundance of their prey rather than by the location of other rays. These speculations are supported by the fact that all three instances of foraging found in this study were in solitary rays. At present, the data is insufficient to distinguish between the two competing explanations. However, the three species system of batoids present in Heron Island provides an ideal site for further research into this topic. Focal follows of individual rays to determine the impact of ray species versus individual size on grouping decisions, as well as a more focused observation of foraging by rays in the study site would help to test these two hypotheses.

### Conclusions

The principal results of this study are two-fold. First, all three species of batoids in this study, the black stingray *D. thetidis*, the cowtail ray *P. sephen*, and the giant shovelnose ray *R. typus*, used grouping as an anti-predator strategy. The behavioral decision to enter into a resting group was shown to vary with predation risk

as determined by individual size as well as by the tidal cycle. Second, mixed species groups were found to be preferred significantly over single species groups. This suggests that the inclusion of multiple species into a group may enhance the effectiveness of groups in alleviating predation risk. A likely mechanism for this difference that needs to undergo further investigation is that the disparate sensory systems represented by the three batoids contributes to a more complete predator detection mechanism than can be afforded by one species alone. In either case, the discovery of two novel species of batoids participating in resting aggregations in a mutual interaction to lower predation risk serves to indicate that this little understood form of mutualism may be more common, and more important, in the reef environment than previously supposed.

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Gen Del Raye is a junior majoring in biology with a concentration in marine biology. Currently his research is focused on the physiology of great white sharks off the coast of California, particularly with respect to the extensive migrations they make to the Hawaiian island chain. Gen spends just about as much time as he can in or around the sea, and when he has a break from classes he would love to be snorkeling, diving, kayaking, or sailing on whatever ocean he finds himself closest to. Gen is also (easily) convinced from time to time to try backpacking and hiking along the coast or in the mountains. He hopes that in the future his research will mature enough to address questions that have an immediate impact on human communities. Gen found Émile Durkheim persuasive when he argued that the purpose of science is to help people understand the consequences of their actions, and Gen believes that the ocean figures strongly in many of the most pervasive actions that we have to contend with today.

# The shading effects of *Dictyota* sp. algae (Dictyotales, Phaeophyta) on *Acropora aspera* coral on the Heron Island reef flat

Andrea Cantu<sup>1</sup>, Jolene Kokroko<sup>1</sup>, Jamie Brett<sup>1</sup>, Megan Grove<sup>1</sup>

A major threat to coral reefs today is the phase shift to algal-dominated reefs. Algae can stress corals by overgrowing and smothering them, blocking sunlight needed for photosynthesis, and enhancing microbial growth. However, the mechanisms underlying algae-coral interactions are still poorly understood. This study examined how the tumbleweed algae *Dictyota* sp. affects the photophysiology of the branching coral *Acropora aspera* at Heron Island, southern Great Barrier Reef, where both species are now commonly found. Algae-covered and algae-free samples from the reef flat and from a three-day aquaria experiment were compared. Dinoflagellate density and chlorophyll *a* content increased in algae-covered coral branches. Therefore, *A. aspera* covered by *Dictyota* was shade-acclimated, which may temporarily protect *A. aspera* from light stress. Future research should address long-term effects, as this study raises the possibility that *Dictyota* shading could either against or enhance thermal bleaching.

## Introduction

In tropical regions around the globe, sea temperatures have increased by almost 1°C over the past century<sup>1,2</sup>. Increasing sea temperatures cause mass bleaching events in coral reefs. Bleaching is characterized by pigmentation loss and therefore reduced photosynthesis in stressed corals, which leads to high coral mortality and poor reef productivity. The effects of warmer temperatures are exacerbated by anthropogenic changes, including increased irradiance and acidity. As sea temperatures continue to rise, the frequency of mass bleaching events will increase<sup>1</sup>.

There is already evident deterioration of coral reef health around the world, as demonstrated by phase shifts from coral-dominated to algae-dominated communities<sup>3</sup>. Many coral reefs have undergone phase shifts due to the combined effects of human disturbances and climate change<sup>3,4</sup>. These phase shifts are frequently attributed to algae outcompeting corals, particularly when coral reef resilience is decreased by bleaching<sup>4,5</sup>. However, there is little direct experimental evidence demonstrating competition between algae and corals<sup>5</sup>.

Thus, as the interactions between algae and corals may increase with rising sea temperatures, it is critical to understand the mechanisms of these interactions.

There are many studies, mostly observational, which have described various effects of algae on corals. Some algae species have been shown to kill corals by smothering and shading, physical abrasion, and enhancing microbial growth<sup>5,6,7,8</sup>. However, algae do not always have negative effects on corals. During the 1998 mass bleaching in the Great Barrier Reef (GBR), the seaweed *Sargassum* shaded and protected corals from bleaching in one area<sup>9</sup>. There is an obvious need to examine the competition between specific algal and coral species.

On Heron Island, in the southern GBR, researchers have recently observed a seasonal influx of the tumbleweed brown algae *Dictyota* sp. This algae is one of the most common along tropical and warm temperate shores<sup>10</sup>. In October 2008, we observed large amounts of *Dictyota* entangled on coral branches throughout the reef flat. This increased incidence of algal-coral interaction led us to examine the effects of *Dictyota* on the photophysiological health of the common branching coral *Acropora aspera*.

To help predict how increasing *Dictyota* at Heron Island could impact the reef ecosystem, we investigated the effects of *Dictyota* on *A. aspera* using two approaches: To characterize these effects in nature, we analyzed photophysiology parameters of algae-covered and algae-free coral specimens from the reef flat. To confirm that these effects are caused by *Dictyota*, we analyzed coral specimens randomly treated with or without algae cover in isolated aquaria.

## Materials and Methods:

### **Coral and algae collection and treatment:**

Three large colonies of *A. aspera* entangled with some *Dictyota* but otherwise appearing healthy were selected on the Heron Island reef flat, southern GBR, during mid-October 2008. 3-5 cm tips of healthy outer branches, located <0.5 m deep during low tide, were removed and immediately transported to aquaria.

For each colony, six algae-free branches were randomly divided into two groups, and each group was suspended in an outdoor aquarium receiving a continuous flow of unfiltered seawater. Aquaria were

<sup>1</sup>Stanford University

partly shaded with a black net to simulate high-tide light conditions of the collection site. After two days of acclimation to the aquaria, one group of branches was embedded in *Dictyota* collected from the reef flat. Corals were then maintained for a further three days before analysis. Days were mostly sunny during the experiment.

Also for each colony, three algae-covered branches and three algae-free branches were randomly selected for immediate analysis, and were maintained in aquaria (algae-covered branches were kept with algae) for no more than 10 hours before use.

### Zooxanthellae, chlorophyll, and surface area measurements:

To measure how *Dictyota* affected the content of chlorophyll *a* (chl *a*) and zooxanthellae (photosynthetic symbiotic dinoflagellates), coral branches were frozen overnight. Coral tissue was completely removed with 50 mL seawater sprayed from an airgun connected to a SCUBA cylinder<sup>11</sup>. The coral skeleton was dried, and surface area (in cm<sup>2</sup>) was determined by the paraffin wax technique<sup>12</sup>.

Zooxanthellae were pelleted by centrifuging the tissue at 4500 rpm for 5 min, and densities were determined by counting dilutions of the pellet on a hemocytometer, averaging six replicate grid counts per branch. Chl *a* was extracted by resuspending the zooxanthellae pellet in 5 mL 100% acetone, sonicating for at least 15 min until cells appeared lysed, and then analyzing the absorbance at 630 nm ( $A_{630}$ ) and at 663 nm ( $A_{663}$ ) on a PharmaSpec UV-1700 spectrophotometer (Shimadzu, Maryland, USA). Chl *a* ( $\mu\text{g/mL}$ ) was calculated as  $11.43A_{663} - 0.64A_{630}$ <sup>13</sup> and normalized to either zooxanthellae cells or coral surface area.

### Quantum yield of photosystem II:

To determine the effects of *Dictyota* on photochemical efficiency, chl *a* fluorescence analysis was conducted on the coral branches with the MAXI-IMAGING-PAM Chlorophyll Fluorometer and ImagingWin v2.30 software (Walz GmbH, Effeltrich, Germany). The effective quantum yield of photosystem II (PSII),  $\Delta F/F'_m$ , represents the proportion of light absorbed by chl *a* that zooxanthellae actually use for photochemistry during the day. This was calculated at 9-11 am for branches taken directly from the reef flat, and at 1-1:30 pm for branches in the aquaria. The maximum quantum yield of PSII,  $F_v/F_m$ , represents the maximum proportion of absorbed light that

zooxanthellae are capable of using for photochemistry because it is measured in the dark; it is always greater than  $\Delta F/F'_m$ . This was always calculated 8:45-9:30 pm. During fluorescence analysis, photons absorbed by chl *a* drive photosynthesis, are dissipated as heat, or are re-emitted as fluorescence. To determine  $\Delta F/F'_m$  and  $F_v/F_m$ , a weak measuring light induced minimum chl *a* fluorescence ( $F$  during the day or  $F_o$  at night). After 5 sec of 280  $\mu\text{E/m}^2/\text{s}$  actinic irradiation for  $\Delta F/F'_m$  measurements only, a high-intensity light pulse temporarily closed all PSII reaction centers to yield maximum chl *a* fluorescence ( $F'_m$  during the day or  $F_m$  at night).  $\Delta F/F'_m$  was calculated as  $(F'_m - F)/F'_m$  and  $F_v/F_m$  as  $(F_m - F_o)/F_m$ <sup>14</sup>. The area of interest was selected as the lower two-thirds of the exposed branch surface, over which fluorescence signals were averaged.

### Rapid light curve analysis:

To investigate how *Dictyota* affected *A. aspera* photochemical performance under rapidly increasing light intensities, rapid light curves (RLCs) were performed at 8:45-9:30 pm. RLCs assess the photosynthetic capacity of corals by measuring their effective quantum yield over a broad spectrum of light in regard to the light-limited photosynthetic efficiency ( $\alpha$ ) of the zooxanthellae, the ability of zooxanthellae to channel absorbed light into the electron transport chain, the maximum relative electron transport rate (rETR<sub>max</sub>) of the zooxanthellae, and the saturation of the electron transport chain<sup>14,15</sup>. Branches were subjected to 16 20-sec actinic irradiance steps, increasing from 0 to 1250  $\mu\text{E/m}^2/\text{s}$ . During each step,  $\Delta F/F'_m$  was determined, and relative electron transport rate (rETR) was calculated as  $\Delta F/F'_m \times \text{irradiance}$ <sup>16</sup>. rETR vs. irradiance was fitted to a double exponential decay function by SigmaPlot 2001 v7.0 (SysStat Software Inc., California, USA) to determine rETR<sub>max</sub> as the horizontal plateau, and  $\alpha$  as the initial slope of the curve<sup>14</sup>.

### Statistical analysis:

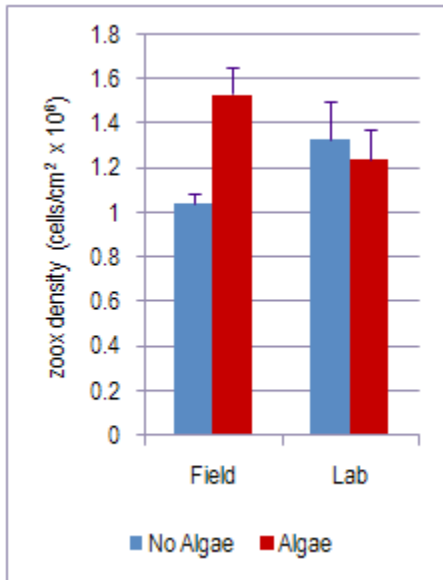
For each colony, triplicate branches were averaged and algae-covered and algae-free groups (n=3 colonies) were compared with paired t-tests. Statistical significance was  $p < 0.05$ .

## Results

### Zooxanthellae density

The algae-covered coral branches from the reef flat had 47% more zooxanthellae per coral surface area than the algae-free branches ( $p = 0.036$ ). For the three-day

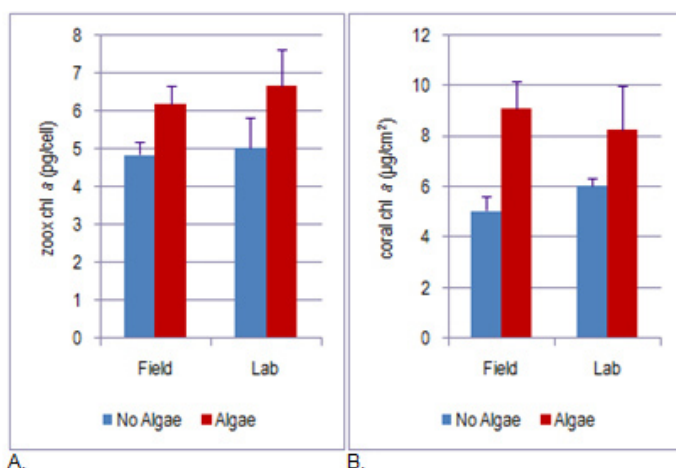
aquaria experiment, however, algae-covered and algae-free treatments did not show different zooxanthellae densities (Fig. 1).



**Figure 1.** Effects of *Dictyota* on *A. aspera* dinoflagellatezooxanthellae density. “Field” represents samples taken from the reef flat; “Lab” shows the aquaria experiment. Shown is mean+SEM (n=3).

### Chlorophyll *a* concentration

Algae-covered coral branches from the reef flat had 27% more chl *a* per dinoflagellatezooxanthellae cell (p=0.180), and they also had higher dinoflagellatezooxanthellae densities, 80% more chl *a* per coral surface area (p=0.035). The aquaria experiment showed similar but not significant differences: algae-



**Figure 2.** Effects of *Dictyota* on *A. aspera* chl *a* content per zooxanthellaedinaoflagellate cell (A) or per coral surface area (B). “Field” represents samples taken from the reef flat; “Lab” shows the aquaria experiment. Shown is mean+SEM (n=3).

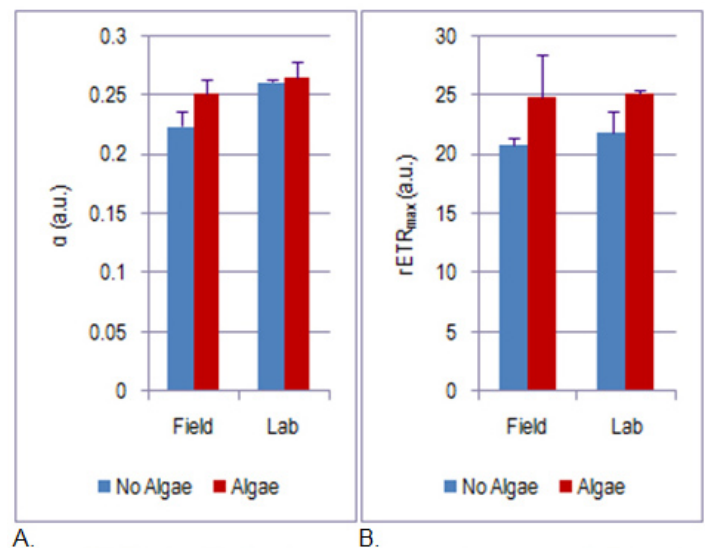
treated branches had 33% more chl *a* per cell (p=0.181) and, without different dinoflagellatezooxanthellae densities, only 36% more per coral surface area (p=0.266) (Fig. 2A,B).

### Quantum yield of photosystem II

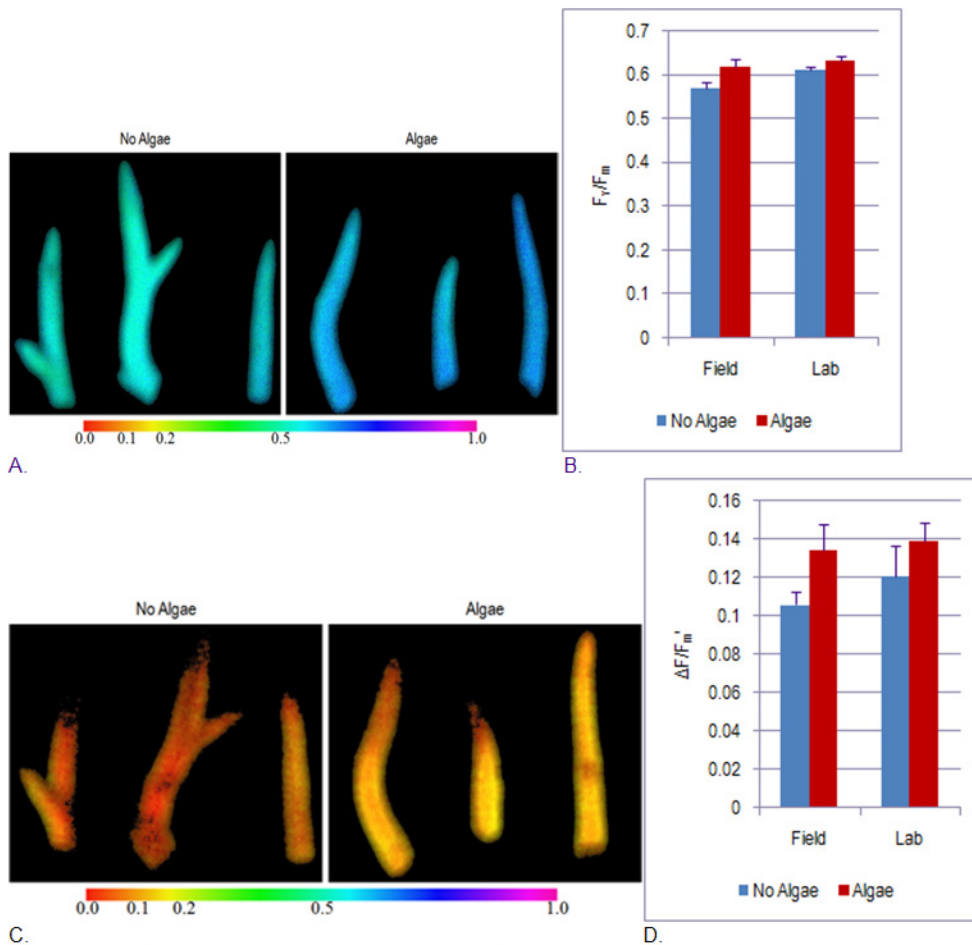
For branches taken from the reef flat, algae-covered branches had higher  $F_v/F_m$  than algae-free branches (n=18, p=0.054). For the aquaria experiment, algae-covered branches had a similar but non-significant trend toward higher  $F_v/F_m$  (p=0.287) (Fig. 3A,B, nextpage). Though not significant, algae-covered branches tended to have higher  $\Delta F/F'_m$  than algae-free branches for both reef flat samples (p=0.369) and the aquaria experiment (p=0.353) (Fig. 3C,D).

### Rapid light curve analysis

For branches analyzed from the reef flat,  $\alpha$  was not significantly different between algae-covered and algae-free branches, but showed a trend of being higher in algae-covered branches (p=0.135).  $\alpha$  was not different between treatments in the aquaria experiment (Fig. 4A).  $rETR_{max}$  showed a notable but non-significant trend between algae-covered and algae-free branches from the reef flat (p=0.403) and in the aquaria experiment (p=0.241) (Fig. 4B).



**Figure 4.** Effects of *Dictyota* on measures of *A. aspera* RLC performance:  $\alpha$  (A) and  $rETR_{max}$  (B). “Field” represents samples taken from the reef flat; “Lab” shows the aquaria experiment. Shown is mean+SEM (n=3).



**Figure 3.** Effects of *Dictyota* on *A. aspera* maximum (A,B) and effective (C,D) quantum yields of PSII. (A,C) Representative measurements of photosynthetic efficiency for branches of one colony from the reef flat. The color scale indicates  $F_v/F_m$  or  $\Delta F/F_m'$ . “Field” represents samples taken from the reef flat; “Lab” shows the aquaria experiment. Shown is mean+SEM (n=3).

## Discussion

### *Dictyota* causes low-light photoacclimation in the zooxanthellae of *A. aspera*

Studies have found shaded corals may increase, decrease, or maintain their content of zooxanthellae, which are photosynthetic microorganisms that provide photosynthate nutrients to the corals that host them. Corals may respond to different light regimes by altering other factors<sup>17,18</sup>, or they may alter the number of zooxanthellae layers to optimize light absorption<sup>19</sup>. The majority of studies have shown shading increases zooxanthellae density, and this change occurs within a few weeks<sup>19,20</sup>. We found algae-covered coral branches from the reef flat had greater zooxanthellae density than algae-free branches, although coral branches covered with algae for three days in the aquaria experiment showed no change compared to algae-free branches (Fig. 1). *Dictyota* therefore appears to be shade-acclimating branches on the reef flat, although changes in zooxanthellae densities may require longer than the duration of the aquaria experiment.

Corals can also acclimate to shade by increasing chl *a* per coral surface area<sup>21</sup>, either by increasing

zooxanthellae<sup>19,20</sup>

or by zooxanthellae producing more chl *a*<sup>22,23</sup>. This change can also be seen within a few days of shading<sup>19</sup>. For both the reef flat comparison and the aquaria experiment, algae-covered branches had more chl *a* per zooxanthellae and per coral surface area (Fig. 2). Therefore, *Dictyota*-covered *A. aspera* branches appear acclimated to lower light, pursuing a strategy of maximizing light absorption by increasing amounts of zooxanthellae and chl *a*.<sup>24</sup>

In both the reef flat and aquaria comparisons,  $F_v/F_m$  tended to be higher in algae-covered corals (Fig. 3A,B), similar to shading studies<sup>15,25</sup>. Zooxanthellae thus appear to respond to algal shade with increased intrinsic photosynthetic efficiency, while algae-free zooxanthellae do not need to be as efficient due to their exposure to higher light levels.

During the daytime, photoprotective mechanisms and photodamage lower  $\Delta F/F_m'$  relative to  $F_v/F_m$ <sup>14</sup>. Lower light levels may increase  $\Delta F/F_m'$ , like  $F_v/F_m$ , due to a reduced requirement for photoprotection<sup>25,26</sup>. Both reef flat and aquaria experiment branches covered with algae had increased  $\Delta F/F_m'$  (Fig. 3C,D). This could be attributed to algal shading: increased intrinsic

quantum yield would maximize photosynthesis<sup>15,24</sup>. More complex fluorescence experiments could determine whether algae-covered branches have higher  $\Delta F/F'_m$  because of less photoprotection or less photodamage<sup>24</sup>.

The initial RLC slope,  $\alpha$ , measures photochemical efficiency at low light intensities, while the maximum electron transport rate,  $rETR_{max}$ , measures ability to maintain photochemistry at higher light intensities<sup>14</sup>. Shaded corals have higher  $\alpha$ <sup>14,15,26,27</sup>, while  $rETR_{max}$  is higher for corals grown in non-damaging light<sup>16</sup>.  $rETR_{max}$  declines during midday as photochemistry through PSII is downregulated in response to high irradiance, a pattern particularly pronounced for shallow *A. aspera*<sup>26</sup>. Prolonged exposure to photoinhibitory light also decreases both  $\alpha$  and  $rETR_{max}$  because photodamage reduces photochemical efficiency at both low and high light intensities<sup>16</sup>. In this study, *Dictyota*-free coral branches tended to have lower  $\alpha$  and  $rETR_{max}$  than algae-shaded branches, and at first glance this appears to suggest that these branches were experienced photoinhibition. However, interpretation of the ETR data will be exercised with caution in this study due to the assumed uniform absorptance properties of the dinoflagellates which may not be valid due to the change in chl *a* concentration.

Many of the changes in dinoflagellate zooxanthellae, pigmentation, and photochemical efficiency were not statistically significant, but their effects may combine: more dinoflagellate zooxanthellae and chl *a* increase light absorption, and higher photochemical efficiency increases photosynthetic use of absorbed light at subsaturating lower light levels. *Acropora* is also known to respond to low light by changing growth form to longer and fewer branches, increasing the amount of photosynthate translocated to branch tips<sup>28</sup>. Thus, a collective view of photophysiological parameters suggests that algae-covered branches are acclimated to lower light, but future research should confirm this by assessing respirometry and colony morphology.

### Implications of *Dictyota* for the susceptibility of *A. aspera* to bleaching

As *Dictyota* shades *A. aspera* branches and protects them from photodamage, it could make *A. aspera* more susceptible or more resistant to bleaching. Bleaching primarily coincides with elevated temperatures, but light stress also plays a role in determining bleaching patterns. In some cases, bleaching is worse in lower regions of corals or in deeper water

corals because dinoflagellate zooxanthellae at these low light levels are less resistant to thermal stress<sup>1</sup>. *Dictyota* shade may prevent corals from acquiring stress resistance mechanisms. This could make algae-covered corals more susceptible to bleaching, especially if wave action dislodges the algae after corals become shade-acclimated.

On the other hand, *Dictyota* cover could protect corals from bleaching, as the *Sargassum* canopy did in the 1998 GBR mass bleaching<sup>9</sup>. Whether shade enhances or reduces bleaching depends on the balance between preventing stress resistance and providing stress protection. If *Dictyota* protection outweighs dinoflagellate zooxanthellae susceptibility to photodamage, after bleaching events *Dictyota*-covered colonies that survive in shallow waters could repopulate this depth faster than could surviving colonies in deeper waters. This faster recovery might become especially important as bleaching events become more frequent<sup>1</sup>.

Our study focused on the short-term effects of *Dictyota* on *A. aspera* in non-bleaching conditions. To investigate the potential roles of *Dictyota* in the long-term and during bleaching events, future research should track *Dictyota* residence time on corals to determine whether it will make branches more susceptible or resistant to bleaching, and heat stress experiments could investigate how *Dictyota* shade might protect corals from bleaching. Aquaria experiments should extend the duration of coral exposure to algae to determine any long-term detrimental effects.

### Conclusions

This study suggests that the short-term effects of *Dictyota* on *A. aspera* branches are not detrimental when it attaches in small amounts to large colonies. Instead, *Dictyota* causes coral acclimation to lower light levels and possibly protects corals from excessive light exposure.

However, the three-day aquaria experiment may not have allowed sufficient time for long-term effects like competition, abrasion, and chemical damage<sup>5</sup>. In addition, only live branches from large colonies could be analyzed, creating selection bias<sup>28</sup>. While long term experiments are required, in the short term, *A. aspera* colonies can co-exist with *Dictyota*.

Because *Dictyota* could become more abundant due to local anthropogenic impacts such as overfishing and nitrification<sup>3</sup>, and its prevalence on the Heron Island reef flat has risen in recent years, further research into its interaction with corals is warranted. If



future research shows that *Dictyota* is harmful to corals in the long run, it may be important to increase herbivore populations around Heron Island. On the other hand, if *Dictyota* proves photoprotective and has minimal long-term negative impacts on corals, herbivory management strategies could aim to maintain a level of *Dictyota* abundance that increases reef survival. Either way, algae-coral interactions should be considered should take this into consideration during monitoring of and response to bleaching events monitored from

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# Thermal Tolerance of Heart Function in Oregon and California Populations of Ribbed Mussels (*Mytilus californianus*).

Lori Westmoreland<sup>1</sup>

This study compared thermal limits of heart function in populations of the ribbed mussel, *Mytilus californianus*, from Boiler Bay, OR, and Monterey Bay, CA. Arrhenius break temperatures (ABTs, a measure of heat tolerance of heart function) were used as the index of comparison. ABTs of Oregon mussels were significantly higher than those of California conspecifics, both before and after a three-month common garden acclimation. The greater thermal tolerance of heart function in Boiler Bay populations is consistent with the occurrence of warmer temperatures relative to Monterey Bay, that result from midday low tides in spring that are uncommon in Monterey Bay. This difference in ABTs suggests that genetic or developmental differences might exist between these two populations.

## INTRODUCTION

The ribbed mussel *Mytilus californianus* inhabits the intertidal environment along the west coast of North America from Baja California to Alaska.<sup>1</sup> *M. californianus* has a wide vertical distribution within the intertidal zone, though it is most commonly found in the mid-intertidal zone.<sup>2</sup> Mussels are immersed in seawater during high tide and emersed in air during low tides; exposure to air can last for hours. During emersion, body temperatures of *M. californianus* can vary widely, from less than 5°C to 35-40°C, depending on latitude, season and orientation of the animal towards the sun.

*M. californianus* conspecifics experience significant differences in the physical environments along the West Coast that may not be simple functions of latitude. *M. californianus* inhabiting the Oregon coast may experience more extreme thermal conditions than conspecifics living further south, because in Oregon low tides in the spring and summer occur at midday, when it is hottest, and winter low tides occur at night, when it is coldest.<sup>1</sup> As *M. californianus* can tolerate such extreme temperatures and maintain this wide latitudinal distribution, it is possible that genetically

distinct populations have developed through adaptation to local thermal conditions. If so, local “warm-adapted” populations may exist to replenish less heat-tolerant populations that become locally extinct due to global warming.

Species with broad distributions such as *M. californianus* are promising systems for elucidating the physiological adaptations that affect geographical range.<sup>3</sup> In the case of the North American Pacific Coast blue mussels, *Mytilus trossulus* and *Mytilus galloprovincialis*, distinct temperature-adaptive differences have been found that may explain why the former species occurs at higher latitudes than the latter species.<sup>3</sup> However, *M. californianus* is currently viewed as a single eurythermal species without any genetically distinct populations.

Heart function as an indicator of mytilid physiological state and stress level has been used successfully in experiments that examined a number of abiotic and biotic factors, including presence of predators<sup>4</sup>, aerial exposure<sup>5,6</sup>, oxygen tension<sup>7</sup>, temperature<sup>3,8,9</sup>, salinity<sup>3,10</sup>, and copper<sup>11</sup>. Variation in basal heart rate and the natural variation that occurs in heart rate over time have also been studied.<sup>12</sup> Genetically based differences have been found in the thermal response of heart function in blue mussel congeners.<sup>3</sup> Whether a similar genetic basis exists for the thermal tolerance of heart function in *M. californianus* has not been investigated.

## MATERIALS AND METHODS

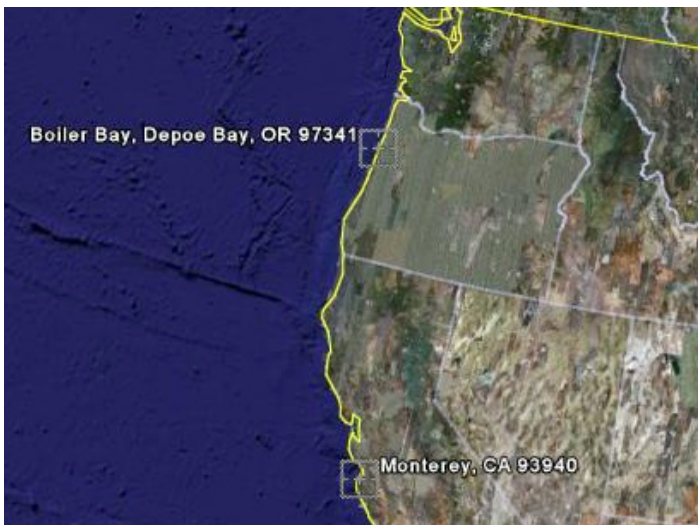
### Mussel Collection and Preparation.

Mussels were collected from surf-exposed rocks in the mid-intertidal zone (Fig. 1) of Monterey Bay, CA (36.6°N 121.9°W) and of Boiler Bay, OR (Fig. 2) in September 2006.

<sup>1</sup>Stanford University



**Figure 1:** Picture of the Monterey Bay, CA, *M. californianus* collection site.



**Figure 2:** *M. californianus* collection sites: Monterey Bay, CA (36.6°N 121.9°W), and Boiler Bay, OR (44°49'40.43N, 124°03'33.30W) (Google Earth).

The mussels were immediately placed in a cooler filled with 14°C filtered seawater and the experiments were run on the day of collection.

Heart experiments followed protocols of Braby and Somero<sup>38</sup>. Two 1.6 mm holes, one on either side of the heart, were drilled on each side of a mussel's shell just posterior to the dorsal shell hinge. Copper electrodes made from 40-gauge wire were inserted and glued into each hole. Electrodes from each mussel were connected to an impedance converter, which provided a voltage signal to an AD Powerlab™ analog to digital converter, which sent a signal of heart activity to a computer. For 3 mussels in each experiment, a third hole was drilled in the center of the shell near the posterior end, and a thermocouple was inserted

for internal body temperature readings. Once mussels were wired, they were immobilized in the experimental chamber by clamps.

### Arrhenius Break Temperature Determination.

The temperature in a water bath containing filtered seawater was maintained at 14°C before the beginning of each temperature ramp, during which the temperature was increased by 1°C every 10 min. The heart rate of each mussel was collected every 5 min for the duration of the heat ramp, until the heart rate exhibited a substantial reduction in beats per minute (BPM). Body temperatures of 3 mussels, recorded every 5 min, were averaged together. Data taken below and above the temperature where heart rate decreased were used to calculate Arrhenius break temperature (ABT), defined as the temperature at which the heart rate begins to decrease instead of increase with rising temperature. An Arrhenius plot (log heart rate vs. reciprocal of absolute temperature) was drawn and the ABT was calculated as the intersection of best-fit linear regressions through rising and falling portions of the data (Fig. 3).

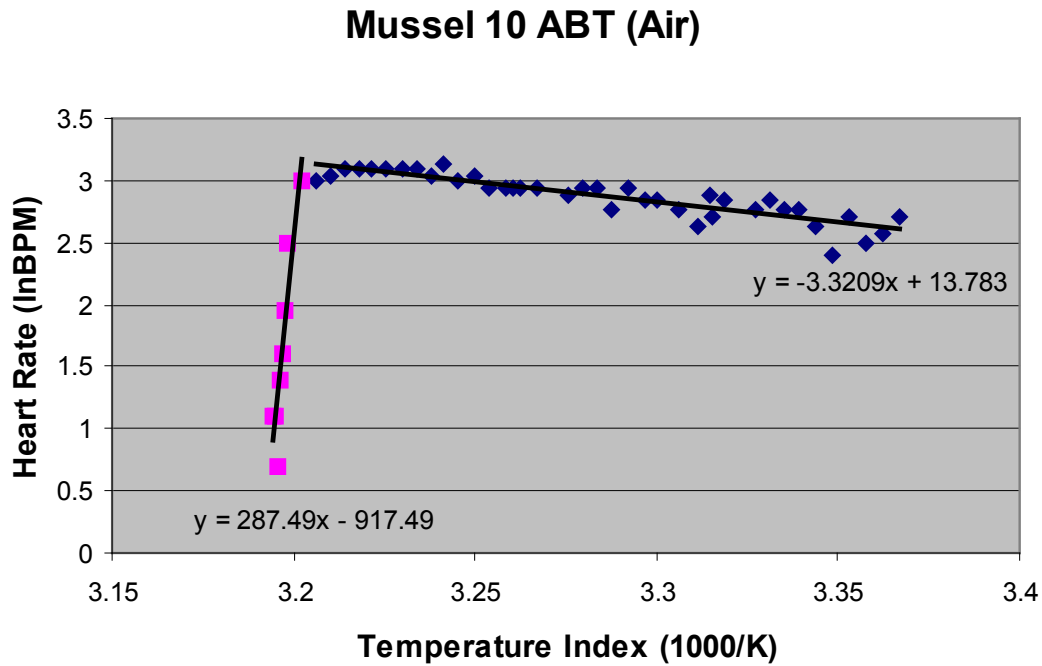
In addition to the ABT, a resting heart rate was calculated by averaging heart rate for the first hour of each experiment for each mussel while held at 14°C.

### Air vs. Water Heart Rate Experiments.

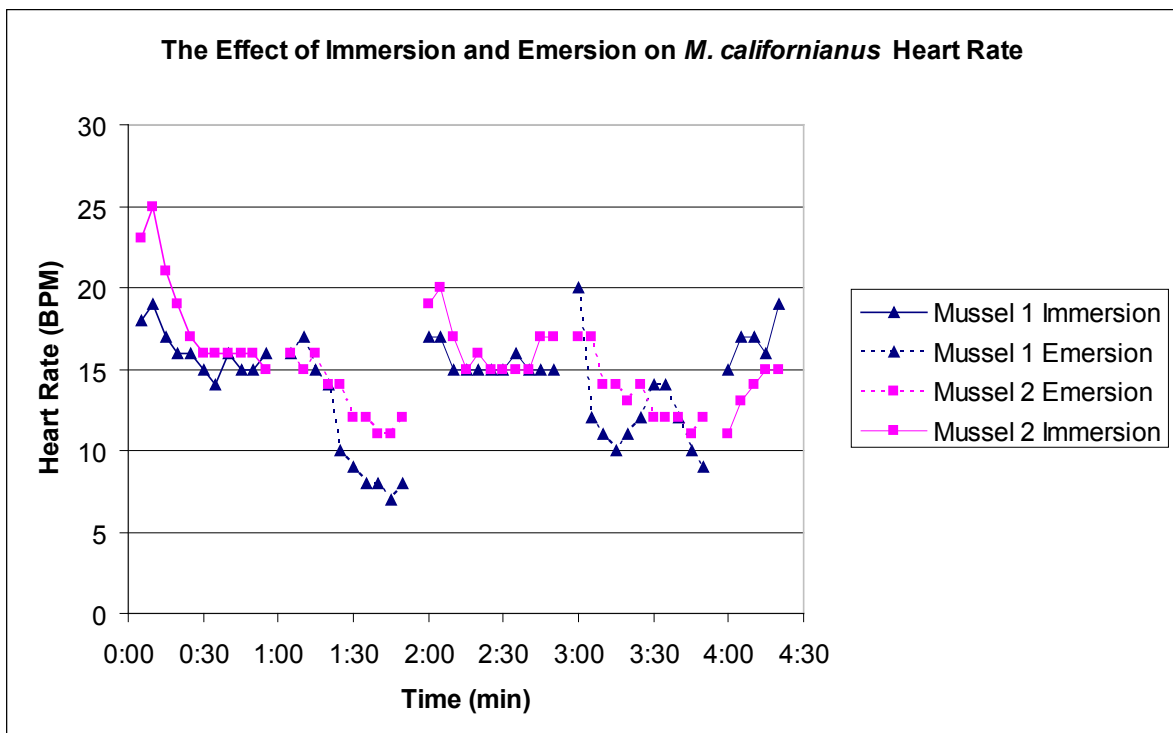
2 mussels were placed in seawater-filled glass jars and allowed 1 h of acclimation at 14°C. While the temperature was maintained at 14°C, the water was drained and refilled at 55 min intervals to simulate 3 periods of immersion and 2 periods of emersion, and individual heart rates were tracked.

### Boiler Bay vs. Monterey Bay ABT Experiments.

Freshly collected specimens: Mussels from Monterey Bay (n = 28) and Boiler Bay (n = 18) were placed in submerged seawater-filled glass jars within the water bath and given 1 h of acclimation at 14°C. Mussels then were emersed in air by draining the water from the jar, and allowed another 1 h of acclimation. A heat ramp was then performed and the ABTs calculated. Air temperature inside the glass jar was controlled by conduction from the surrounding water bath.



**Figure 3:** Example of an ABT plot for a mussel from Boiler Bay, OR.



**Figure 4:** Heart rate of two *M. californianus* specimens (Monterey Bay) vs. time with two long periods of immersion (solid lines, 0:00- 0:55, 1:55-2:45), one short period of immersion (3:55-4:15), and two periods of emersion (broken lines, 1:00-1:45, 2:55-3:45).

Common gardened specimens: Mussels were acclimated at 14°C for 3 months, and fed twice per week with Shellfish Diet (Reed Mariculture). 18 common gardened mussels from each site were subjected to air heat ramps, as for the freshly collected specimens. Resting heart rates and ABTs were calculated for all 36 specimens. A two-way ANOVA test was performed using SYSTAT (SSI, San Jose, CA).

## **RESULTS**

### **Immersion vs. Emersion Heart Rates.**

Heart rates of Monterey mussels rose during immersion and fell during emersion (Fig.4). The average heart rates of the two mussels were 15.96 and 16.63 BPM during immersion and 11.76 and 13.38 BPM during emersion. There was an initial drop in heart rate, most likely due to the heart rate settling after the mussels were prepared for the experiment.

### **Arrhenius Break Temperature in Air vs. Water.**

Eight *M. californianus* specimens from Monterey were subjected to a heat ramp in water and displayed an average ABT ( $\pm$  Standard Deviation) of  $36.35 \pm 0.72^\circ\text{C}$ . Twenty-eight mussels subjected to a heat ramp in air had an average ABT of  $34.8 \pm 0.40^\circ\text{C}$ . Thus, Monterey mussels showed a trend toward having

lower ABT values in air (t-test,  $P = 0.072$ ).

### **Boiler Bay, OR vs. Monterey Bay, CA Mussel ABTs.**

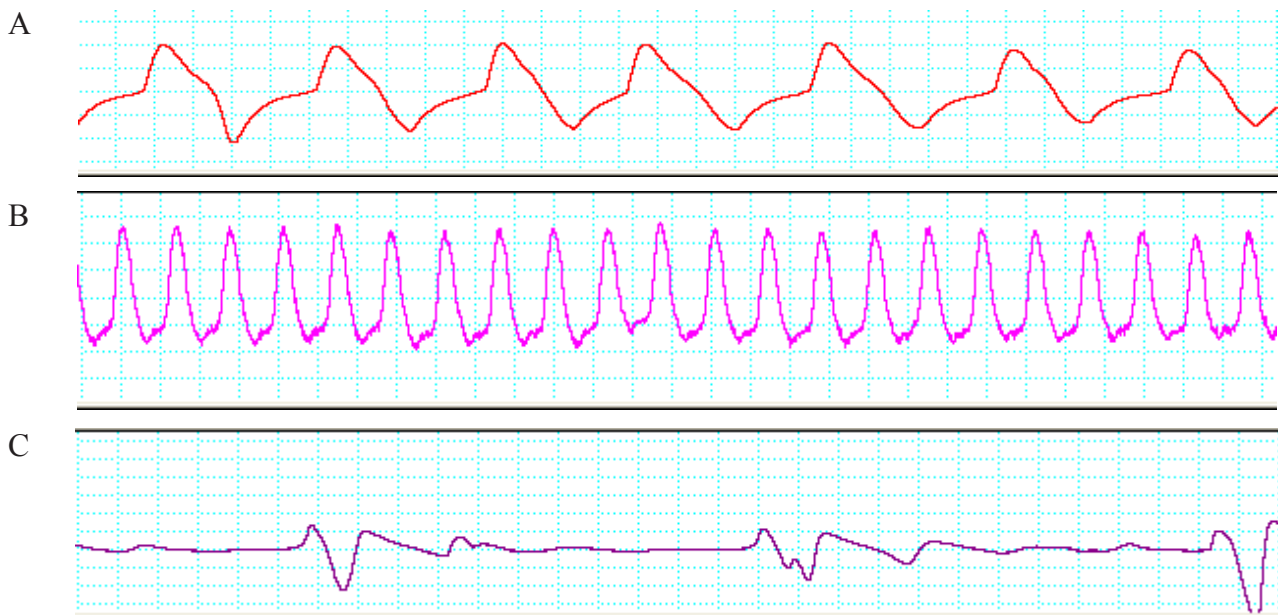
Boiler Bay mussels had a significantly higher ABT in air than Monterey Bay mussels, in freshly field-collected and common garden-acclimated specimens ( $p < 0.001$ , ANOVA) (Fig. 6).

The three month common garden treatment did not significantly alter the ABTs from pre-common garden treatment averages (difference of  $0.3^\circ\text{C}$  for Boiler Bay, OR, and  $0.1^\circ\text{C}$  for Monterey Bay, CA).

Resting heart rate was generally lower for Boiler Bay, OR mussels, but there was no significant difference between resting heart rates for CA and OR mussels either before or after the common garden treatment (ANOVA, Student-Newman-Keuls test; data not shown).

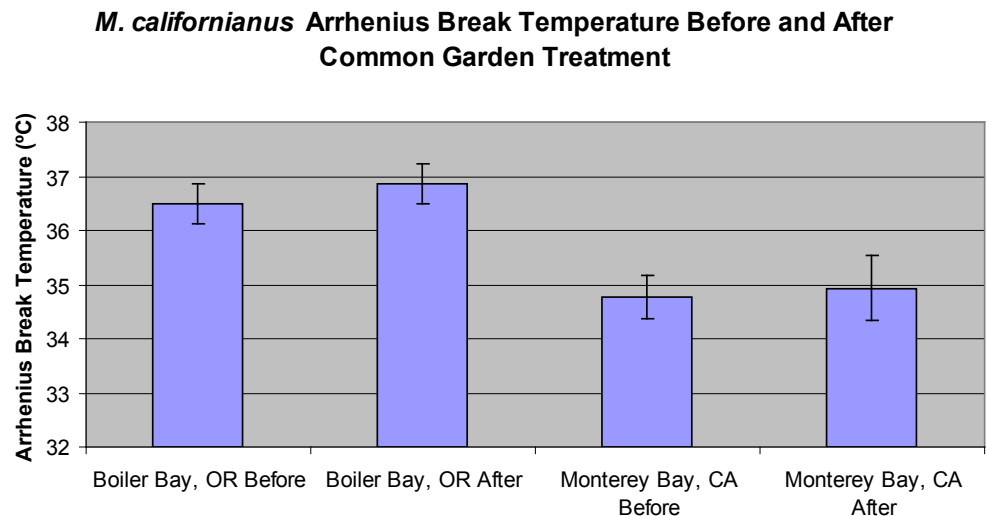
## **DISCUSSION**

**Immersion vs. Emersion in *Mytilus californianus*.** The reduction in heart rate observed during air exposure, followed by rapid recovery upon re-immersion, is consistent with previous studies of mytilids.<sup>5, 6</sup> Bivalves typically experience bradycardia during air exposure.<sup>13</sup> Emersion causes valve closure, which leads to lower heart rate and reduced oxygen availability in tissues.<sup>3, 5</sup> The increase in heart rate upon



**Figure 5. Heart rates over 1 min.** A. Specimen from Monterey Bay at  $14.6^\circ\text{C}$ . B. Specimen from Monterey Bay at  $34.5^\circ\text{C}$ , approaching the ABT. C. Specimen from Boiler Bay at  $36.5^\circ\text{C}$ , decreasing and irregular heart rate above the ABT.

**Figure 6.** Mean ABT comparing Boiler Bay and Monterey Bay *M. californianus* before and after the common garden treatment. Each value is mean  $\pm$  standard error.



re-immersion may be associated with payoff of oxygen debt incurred during emersion.<sup>14</sup>

**Arrhenius Break Temperature in Air vs. Water.** There was no significant difference in the ABTs of immersed or emersed *M. californianus*, which is consistent with previous studies of *M. californianus*<sup>1, 8</sup>, *M. edulis*<sup>9</sup> and *M. edulis*, *M. galloprovincialis*, and *M. trossulus*.<sup>3</sup> That break temperature is unaffected by immersion or emersion suggests that the break temperature is a physiologically inherent characteristic of the mussel.

**Boiler Bay, OR vs. Monterey Bay, CA conspecifics.** ABTs of mussels from Oregon remained significantly higher than California specimens even after three months of acclimation to identical conditions. Mussels usually acclimate quickly, and therefore three months should have been long enough to eliminate environmentally induced differences in ABTs.<sup>15</sup>

Higher ABT values in the Boiler Bay specimens are consistent with the more extreme temperatures in Oregon where low tides in the spring occur at midday when it is hottest, and low winter tides occur during the night when it is the coldest.<sup>1</sup> Helmuth et al.<sup>16</sup> also found that northern sites along the West coast of the United States experience more stressful temperatures than southern sites, and that this stress could affect distributions of intertidal organisms such as *M. californianus*. That ABTs of mussels from Oregon and California remain significantly different even after three months of identical acclimation suggests that these two populations may be genetically different, due in part to

adaptation to these extremes.

In the future, these two populations should be studied more extensively to try to understand the mechanistic basis of the higher ABT for the Boiler Bay mussels, in particular whether it is due to genetic or environmentally-induced developmental differences. We still have only a limited understanding of the biochemical mechanisms that establish biogeographic distribution limits. Populations of ribbed mussels offer considerable potential for elucidating these mechanisms and providing a more thorough foundation for understanding the effects of environmental change.

#### **ACKNOWLEDGEMENTS**

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# Group Dynamics and Interactions between Two Cohabiting Damselfishes, *Dascyllus aruanus* and *Pomacentrus moluccensis*

Anna Gillespie<sup>1</sup>

This paper examines the relationship between *Dascyllus aruanus* and *Pomacentrus moluccensis*, two species of damselfish which commonly form mixed colonies on the reef flat of Heron Island, in Australia's Great Barrier Reef. *D. aruanus*, commonly known as the Humbug Damselfish, has been extensively studied. They defend their territory (consisting of branched coral) and form both conspecific and bispecific groups, cohabiting with a range of other similar damselfish species<sup>1,3,8</sup>. These groups include a range of fish sizes in a strict hierarchy led by a single dominant male of either species<sup>2</sup>. *P. moluccensis* has not been studied as thoroughly but has been shown to form groups with Humbugs and shares many of their characteristics<sup>1,9</sup>. To investigate the relationship between these species, 25 coral heads supporting bispecific and conspecific fish colonies were measured and the fish were counted and placed within size categories. The data revealed no significant correlation between coral size and group size, indicating an adequate resource supply. There was also a differential distribution of fish sizes found for each species, suggesting different ecological dynamics. The results suggest that the two species preferentially live together, with the dominant adult in each group equally likely to be of either species. This project raises a number of further questions and requires elaboration with a larger sample size and minimization of bias.

## Introduction

*Dascyllus aruanus*, the Humbug Damselfish, is one of the more common fish seen on shallow reef flats in the Great Barrier Reef. It has a persistent (possibly obligate) relationship with branching corals, which it uses as a nocturnal refuge from predators. Individuals tend to stay near the same coral head once they have settled as juveniles, although they travel over a wider area when the corals are closely packed and continuous<sup>1</sup>. *Dascyllus* generally define a territory which can consist of a single coral head or a small area of continuous coral, and which generally supports either bispecific or conspecific groups of fish. Humbug Damselfish

maintain their territory while feeding, and simply swim up the water column above their coral, often in groups, to prey upon plankton<sup>2</sup>. Adult fish show aggressive behavior towards potential predators coming into their territory, but rarely harass members of other species with similar niches. This indicates that the motive is to prevent predation rather than to reduce competition<sup>3,4</sup>.

*Dascyllus* are rarely found alone; they both forage and share territories as groups. Fish within these groups are subject to a strong, size-based dominance hierarchy. When settling, juveniles are likely to settle on corals which already house their species or even groups of other damselfish with similar habits<sup>1,3,5,6,7</sup>. This gives the young fish better protection against predators primarily due to the territorial defense by the adult fish, but the juveniles also benefit from increased group vigilance since the larger fish swim further above the coral. Additionally, the presence of other fish may serve as an indicator of a favorable habitat<sup>1</sup>. *Dascyllus* species show high growth plasticity, a characteristic which allows each individual to adjust its growth rate based on the size and number of other fish in the group. This strategy reduces the rate of resource consumption of the group as a whole<sup>3</sup> and leads to the expectation of a uniform distribution of sizes represented within the colony.

The complex relationships within each group of *Dascyllus aruanus* extend to their interactions with other cohabiting damselfish. Humbug Damselfish and *Dascyllus marginatus* were often found to inhabit the same coral, and seem to function nearly as the same species. Feeding behaviors, life span, and home ranges are similar, while the only characteristic separating the species seems to be reproductive physiology. Bispecific groups have a single dominance hierarchy, and juveniles show no settlement preference toward their own species when choosing a pre-established group to join<sup>4</sup>. The bispecific group was also observed to occur with *Dascyllus melanurus*, and Limbourn *et al* reasoned that, according to competition theory, there should be a lower overlap in resource use in regions of sympatry due to resource partitioning or displacement of the weaker competitor. Alternatively, if a resource were limited by geography or availability, resource use

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should converge in areas of sympatry<sup>8</sup>.

I undertook a study of the behavioral and ecological relationship between Humbug Damselfish and Lemon Damselfish (*Pomacentrus moluccensis*). At Heron Island in the southern Great Barrier Reef, the two species share the same habitat preference, feeding strategy and prey, group dynamics, and settlement preference<sup>1,9</sup>. Although it is clear that cohabitation occurs, the relationship between *D. aruanus* and *P. moluccensis* has not been well characterized. In order to gain a holistic understanding of the group structure and behavior both within and between the two species, several questions were posed.

First, it was hypothesized that there would be a positive relationship between the number of fish in each conspecific or bispecific group and the size of the coral territory. Based on competition theory, it would seem that the more coral a colony inhabited, the larger feeding area would be used above the site, and the more resources would be available per fish. Also, a larger fish group might be able to defend a larger area of coral with the same effort as a small number of fish defending a small territory. Second, the group dynamics and percent composition of the colonies were investigated. Considering the growth plasticity of *D. aruanus* and potentially *P. moluccensis*, it was expected that groups would show a uniform distribution of fish sizes with the exception of the single largest fish, the dominant individual. Third, interspecies interactions were expected to follow the pattern of the other observed interspecies relationships. A higher frequency of bispecific groups was expected than occurrence of either

species alone. It was projected that since Humbugs tend to reach slightly larger sizes than Lemon Damselfish<sup>10, 11</sup>, there would be a higher proportion of dominant male Humbugs. With these hypotheses in mind, this research set out to characterize the *D. aruanus* and *P. moluccensis* fish colonies.

## Materials and Methods

All data for this project were collected over a three-day period during October 2008 on the mid-reef flat off Heron Island in the Great Barrier Reef (23°26'S; 151°54'E). Data collection consisted of identifying an *Acropora* coral head containing either Humbug or Lemon Damselfish, counting the members present of each species of interest, and classifying them into length categories: 0-2 cm, 2-4 cm, 4-6 cm, 6-8 cm, and 8-10 cm. The length, width, and height of each coral head were measured with a meter stick with 10 cm increments. Coral volume was assumed to be proportional to the product of length, width, and height; area was assumed to be proportional to the product of length and width. Careful survey planning ensured that coral heads were not recounted. Data from 25 coral heads were considered sufficient given the pilot nature of the research being conducted as part of the Stanford Australia Bing Overseas Program. Data analysis included simple averages, Student's *t*-tests, linear regression analysis, and chi-square tests.

## Results

Linear regression analysis comparing the coral area and volume data to the size of fish groups showed no clear trends (Fig. 1). The range of coral sizes and fish

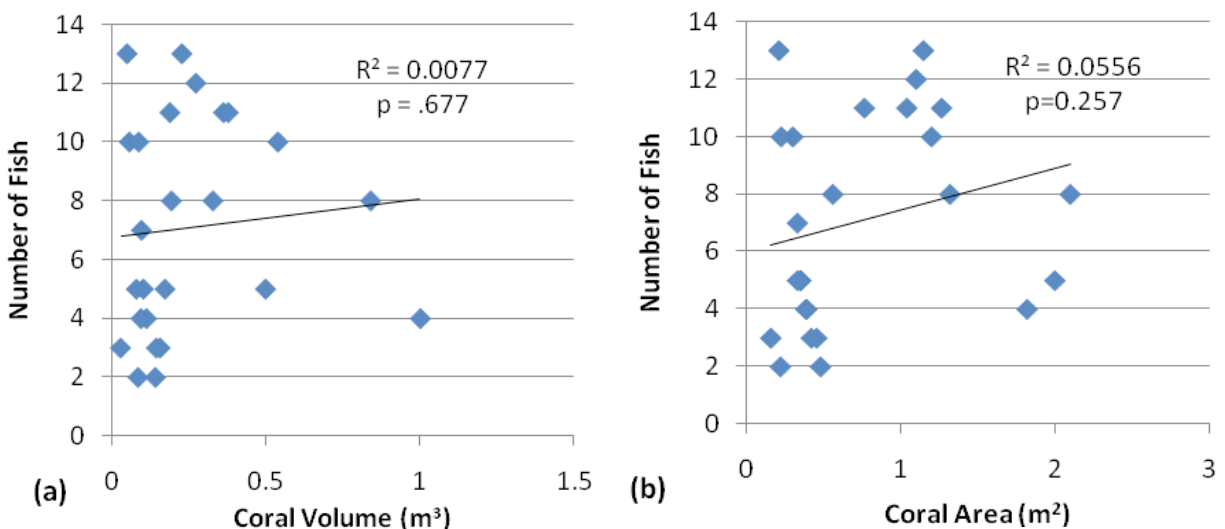


Fig. 1: Total fish number (*D. aruanus* and *P. moluccensis* combined) compared to coral head volume (a) and area (b).

group sizes was high, and regression analysis provided a p-value much greater than 0.05 and R<sup>2</sup> values very close to zero for all of the graphs.

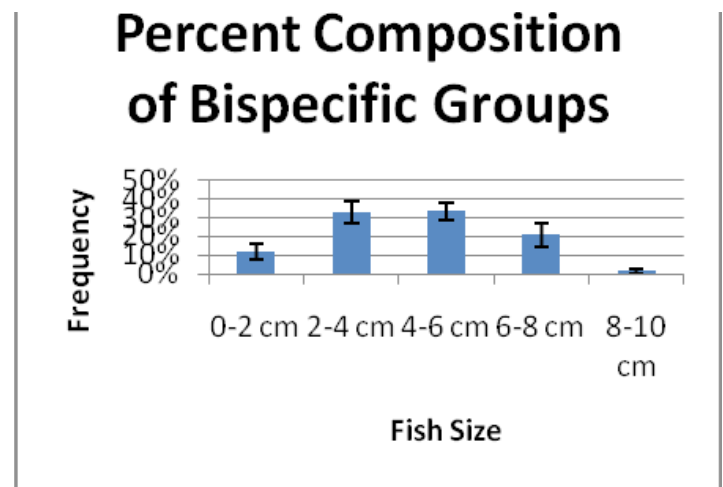
The average percent composition charts showed distinct distributions of fish size within bispecific as well as conspecific fish groups. Frequencies were compared using Student's *t*-tests. The average percent composition of the total fish group shows a noticeably weighted distribution favoring medium-sized fish over the largest and smallest fish (Fig. 3a). The three groups of medium fish (2-4 cm, 4-6 cm, and 6-8 cm) were indistinguishable from each other, but all these frequencies were significantly higher than those for the 0-2 cm and 8-10 cm categories. The one exception to this was the difference between the 0-2 cm fish and the 6-8 cm fish, which maintains the trend but was insignificant. The 8-10 cm size class had a significantly lower frequency than the 0-2 cm category. When the histograms were split by species, two individual patterns emerged. The Lemon Damsel fish showed a more uniform percent composition, with the only significant difference found between the 0-2 cm size category and the 2-4 cm group (Fig. 3b). The relationships between all the other size classes were close enough to be statistically indistinguishable. Conversely, the average composition of the Humbug fish shows a trend even more significantly weighted than that of the total average composition (Fig 3c). The three middle categories were once again statistically indistinguishable, and with the exception of the difference between 0-2 cm and 6-8 cm classes, the middle categories are significantly different from the largest and smallest classes. The two opposite extremes (smallest and largest) are statistically impossible to differentiate.

The tendency of the two species to cohabitate was observed, but the data was inadequate to statistically indicate a difference. The frequency of bispecific groups was far higher than conspecific groups of either Humbug or Lemon Damsel fish (Table 2). This suggests that the two species preferentially live together, although in order to prove this, more data would need to be collected. The chi-square test was applied to see if the ratio of dominant males of each species was any different from the 50/50 percent predicted by random chance. A chi-square value of 0.066 ( $p = 0.80$ ) indicates that the values were not significantly different (Table 3).

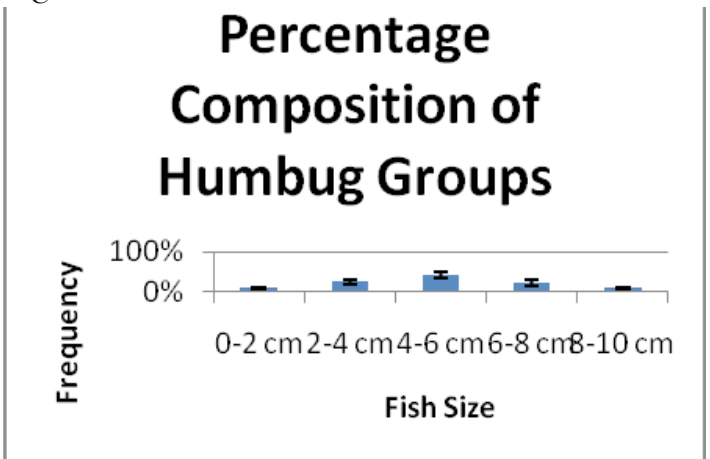
### Discussion

The lack of correlation between coral size and fish group size provides interesting insights into the habits and environmental conditions experienced by these two fish species. Based on the findings of Limbourn *et al* (2007) in regards to competition theory,

A



C



B

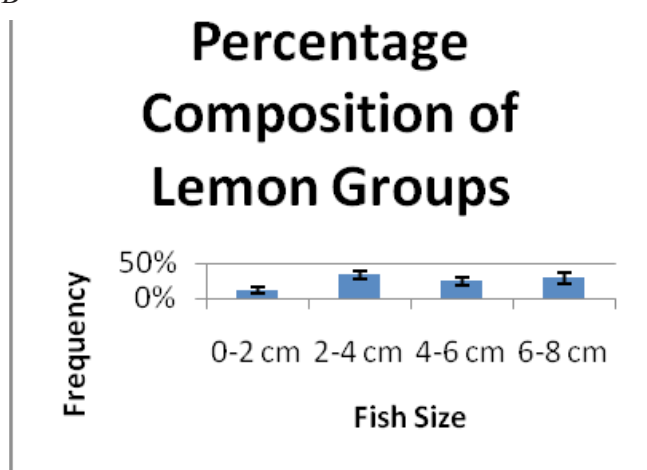


Fig. 3: Average percent composition of the bispecific (a) and conspecific (b and c) fish groups.

	Observed
<i>P. moluccensis</i> only	3
Both species present	18
<i>D. aruanus</i> only	4
Total Colonies	25

Table 2: Fish colonies containing either or both species.

	Observed	Theoretical
Humbug dominant	7	7.5
Lemon dominant	8	7.5
Total dominant	15	15

Table 3: Clearly identifiable dominant males within bispecific colonies

both *D. aruanus* and *P. moluccensis* probably inhabit the same niche and therefore use the same resources. Since the size of the coral does not limit the size of the fish group, it would seem that the resources must be abundant. From personal observation, even the smallest coral heads were sufficiently large to hide all the fish in the group, so space is likely not a limitation. Perhaps more crucial is the food supply, and since the fish generally feed directly above their own coral, the amount of plankton in the water would control the number of fish that could feed successfully in a restricted area. The results imply that the amount of plankton (or other resources necessary to the fish) is high enough not to be a limiting factor in the abundance of these fish on Heron Island. In addition, the lack of correlation between coral size and group size suggests that the fish do not colonize new coral as the group expands. Although more fish would potentially have the ability to defend a larger area of coral, perhaps it does not happen because the responsibility of defense falls only on the few largest fish in the group<sup>4</sup>. Overall, the failure to define a relationship between coral size and fish group size indicates the adequate supply of resources on the reef as well as the tendency to maintain the same coral area instead of colonizing new areas as the group recruits new members.

The average percent composition of the fish groups also provides insights regarding the settlement of young fish, as well as the group dynamic overall. When both species are considered in the size histogram of the group, the average composition shows a significantly weighted distribution favoring medium-sized fish. This indicates that growth plasticity is not the only factor influencing the size of fish in the colony, since complete growth plasticity would likely result in a uniform distribution between the categories of fish size<sup>3</sup>. When the two species are split apart for independent analysis, the Humbug Damsel fish show an even stronger weighted distribution, still favoring

medium-sized fish. The scarcity of very small fish can be attributed to high juvenile mortality rates and the difficulty of finding suitable settlement locations<sup>7</sup>. In addition, this class may be underreported, since the small fish are more difficult to see and to count. The scarcity of very large fish may be due to increased predation and age-related factors. The largest fish are generally the defenders of the coral, and may swim further from the coral, increasing their risk of predation<sup>6</sup>. Unsurprisingly, these fish tend to be the most aggressive and may seek confrontation with other fish that could result in harm to the Humbug. Additionally, these fish are most likely the oldest in the group and are the most likely to die of age-related problems. Contrastingly, the Lemon Damsel fish population produced a much more uniformly distributed histogram. High juvenile mortality probably accounts for the small proportion of the smallest fish, but the relatively high percentage of large fish demands an explanation. The most likely cause is the slight difference in maximum size of the fish. Humbugs grow to a maximum of 10 cm<sup>11</sup>, while Lemon Damsels generally only reach a length of 9 cm<sup>10</sup>. Because the largest Lemon Damsels in each group are likely to be smaller than the largest Humbugs, they are likely to contribute less to the defense of the coral head and therefore may have a smaller risk of predation and confrontation. The contrasting histogram patterns are the first difference noted in this study between the two species and may be attributable to the small disparity in average size of the fish species.

Previous studies demonstrated the preference of Humbug Damsel fish to live with other similar species<sup>1,8</sup>, and the present study similarly suggests that this relationship holds true between Humbugs and Lemon Damsel fish. The high level of cohabitation supports the hypothesis that the fish species prefer to live together. This can be explained by the proven tendency of Humbug (and likely Lemon) juveniles to settle in a coral with an existing group of fish, regardless of whether that group is of its own kind or of the cohabiting species. This increases the number of potential locations for settling and results in a high proportion of bispecific groups. Although it was hypothesized that there would be a higher number of dominant Humbug males than dominant Lemon Damsel males because of the size advantage, the results were not statistically significant. This suggests that the potential size difference between the fish had little effect on the species of the dominant

male, as observed in other studies<sup>6</sup>.

In general, the trends found (or lack thereof) were informative in this study. It is now clear that coral size is not significantly correlated with the number of fish per colony, and that the two species have slightly different size distributions as shown by the histograms. It is also clear that *D. aruanus* and *P. moluccensis* preferentially live together, and that the dominant male of each fish group is equally likely to be of either species. However, there are several factors in this experiment that could have affected the stated results. Primarily, the sample size was relatively small, although still useful for a pilot study. In order to truly verify the results given here, far more coral heads must be surveyed—especially because the coral heads in this study were not a random sample. Ideally, transects would be taken and all coral heads would be counted, including those without Humbug or Lemon Damsel fish. This would allow for a less biased survey of all the fish groups and would enable further statistical analysis to determine the significance of the fish group distribution pattern. More stringent methods of approximating volume and area need to be used, as the measurements in this study relied on potentially imperfect assumptions of dimensional proportionality. Finally, identifying the dominant adult was not a priority of this study, and the identification was based on size, after observations were taken. This method was likely to be accurate except in the groups which had at least one fish of each species in the largest size category, making it impossible to identify the dominant adult. In an improved study, more effort should be put toward identifying a dominant individual while observing the group. In order to extend knowledge further, it would be useful and relevant to try to quantify the behaviors of this dominant individual. Although this is a significant foundational study on the characteristics of *Dascyllus aruanus* and *Pomacentrus moluccensis* and the interactions between the two species, there is much still required in order to elucidate this relationship fully.

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