



# DUURJ

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Undergraduate Research Journal

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Volume 2, Spring 2020



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Image of the Jambiani coast off of Zanzibar.  
Photograph taken by Hanna Gaertner

Dear Reader,

The sophomore slump exists in all areas of creation. Students with a second year of school; musicians with a second album; athletes and television shows with their second season; and most classically, movies and sequels. I'm proud to say, with our second issue of the DU Undergraduate Research Journal, the sophomore slump does not exist. In fact, this issue is even better than the last.

The first issue of our journal was released on January 3rd, 2020. It was built by seven students, all brought together by word of mouth, and consisted solely of papers accrued through personal connections. While the workload per person was larger, and the work itself a little less thorough, the experience had its own advantages. It was personal, rewarding, and grassroots in nature.

Since that debut, our journal's complexion has changed dramatically. Those seven students now hold upper-level positions and our staff has grown fivefold. Due to an abundance of submissions, we had to carefully pick and choose which papers were published. Professors actively reached out to us, asking permission to connect our journal with their students. This issue has an even greater air of professionalism, selectivity, and confidence. This does not make it a worse or better experience to create than the last, rather just different.

To those original seven: Annie, Adam, Will, Chloe, and Emily, your dedication, enthusiasm, and patience (particularly with me) were the biggest factors in making this journal possible. These fifteen months have certainly been hard at times, but I would not trade them for the world. To all of the section and copy editors who contributed to this issue, thank you for all of your hard work -- I cannot wait to see how you build on what we have already accomplished together. Lastly, thank you to you, the reader. Without your feedback and curiosity, there would be no need for DUURJ.

As for my tenure as editor in chief, this issue marks both the last publication and a responsibility to pass the torch. To the new editor: recognize that while your position might feel like a job at times, it's supposed to be a playground for leadership, creativity, and community. Learn from the position, but more than anything, enjoy it.

At its current stage, this journal represents fifteen months of hard work. This makes letting go of the reigns difficult. But, when I first started to conceive of the idea for what would become the DU Undergraduate Research Journal, I did not expect to write one letter from the editor, let alone two. I find solace in understanding that I am leaving a legacy not for me but for the DU community. I think Winnie the Pooh described this feeling best when he said, "How lucky I am to have something that makes saying goodbye so hard."

Sincerely,

Carrie Hicks  
*Editor in Chief*

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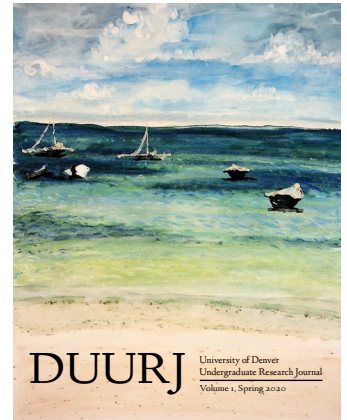
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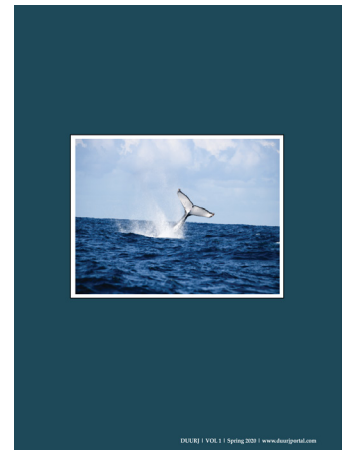
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# The Community Influence of Sponge and Coral Aquaculture in Zanzibar

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## Abstract

Aquaculture has been presented as a means of income for coastal communities, particularly in the context of climate change and resource exploitation. The NGO Marine Cultures in Jambiani, Zanzibar has established a sponge cultivation program for women in response to declining feasibility of seaweed farming from warming ocean temperatures. In addition, the organization strives to restore a severely damaged reef while providing employment for coral farmers and tour boat operators. This study analyzed the influence of aquaculture on community stakeholders, primarily with respect to sponge cultivation and secondarily in regard to coral farms. Using Marine Cultures as a case study, the principal aim was to investigate the impacts of sponge farms on the lives of women, with supplementary examination of the coral project and potential for community benefit. Participant observation and interviews were employed to generate qualitative data about the farms themselves, Marine Cultures, and the individuals impacted, predominantly women sponge farmers. The results of the study were a holistic narrative of Marine Cultures, four biographical sketches (three sponge farmers and one coral farmer) and a clear representation of aquaculture's benefits to individuals.

## Dhahania

*Kilimo bahari kilifanywa ikiwa ni njia ya kujipatia kipato kwa jamii ya watu wa mwambao wa Jambiani, Katika kukabiliana na hali ya tabia nchi na uvunaji wa maliasili. Taasisi isiyo ya kiserikali ya Kilimo bahari katika eneo la Jambiani, Zanzibar walianza upandaji wa spongi bahari (vinja bahari) kwa Wanawake kutoka na wasiwasi wa kushuka kwa uzalishaji wa mwani kutokana na kupanda kwa joto la bahari. Kwa kuongezeka, taasisi hii inaangalia uwezekano wa kurejesha matumbawe yaliyoathirwa kwa kiwango kikubwa wakati huohuo wakitoa ajira kwa Wakulima wa Matumbawe pamoja waendesha boti. Utafiti huu ulichunguza pamoja na kuchambua ushawishi wa kilimo bahari kwa washika dau wa jamii ya Jambiani, kimsingi kwa kuzingatia kilimo cha Spongi na kilimo cha Matumbawe. Kwa kutumia jumuiya ya "Marine Culture" eneo la Kujifunzia, Madhumuni ya msingi yalikuwa ni utafiti kilimo cha mashamba ya spongi pamoja na maisha ya wakulima wa kike, utafiti wa ziada wa kilimo cha Matumbawe na faida kilimo kwa wanajamii. Uchunguzi kwa vitendo na mahojiano ulifanyika ili kuweza kupata data kuhusiana na mashamba yao, Kilimo bahari, na waathirika, Mara nyingi wakulima wa spongi ni wanawake. Matokeo ya utafiti huu ni kwa ujumla yanasimulia "Marine Cultures," 4 michoro ya kibinadamu (3 wakulima wa spongi, 1 mkulima wa matumbawe) na uvakilishi mzuri wa faida kwa kilimo mmoja.*

**Keywords:** aquaculture – sponge farming – Zanzibar – coral farming – marine cultures – community impact

## 1 INTRODUCTION

This study analyzed the relationships between aquaculture and community stakeholders in Zanzibar. The first aspect was creating a comprehensive narrative of Marine Cultures, an NGO of Swiss origin based in Jambiani. The narrative includes a timeline of the organization's history, as well as information regarding Marine Cultures' communication of their mission, relationships with community members and partners, challenges,

evaluation of current sustainability, and future goals. The second aspect was to develop a thorough comprehension of sponge farming processes via participant observation in the field, and to observe coral maintenance to understand the reef restoration project. Lastly, this study investigated the implications of aquaculture for participants. Sponge farming was examined through women involved in the project, including its potential for income generation, successes and challenges,

transferable skills, and gender dynamics. For the coral restoration component, the study then focused on coral farmers as well as a boat captain, also seeking to evaluate economic benefit, skills development, challenges, and practicality.



Figure 1. Underwater image of shallow water sponge farm.

Previously, no official record (aside from brief annual reports on their website) existed of Marine Cultures' history, development, community relationships, organizational goals and overall stake in addressing issues of poverty, resource exploitation, and environmental degradation in Zanzibar. Moreover, an understanding of the organization and its practices (i.e. mechanics of aquacultivation) were essential to proceed with the examination of the NGO's impacts on women who participate in sponge farming and the recent development of coral restoration. Thus, this study is a valuable resource for present and future stakeholders of Marine Cultures. In particular, the results provide a deeper understanding of community relationships with sponge cultivation through the lens of female sponge farmers as well as insights into the integration of coral restoration into the community via men who grow corals.

Since the efforts of women to address social challenges in an entrepreneurial context have great potential to impact their communities and their nations<sup>1</sup>, it is important to be aware of the effects of such activities on the women involved in them, with sponge farming as the primary example. Awareness of impacts is influential for assessment of future project feasibility on larger scales or in other contexts, as well as for the communication of human narratives that have not previously been told in depth. In fact, little is known throughout the world about Zanzibari women in general, and the limited information available tends to highlight a "mysterious" or "exotic" quality due to misunderstood cultural and religious practices<sup>1</sup>. This study assists in the alleviation of such misunderstandings and provides insights as to how women are impacted as they facilitate

productive community change.

The importance of understanding reef restoration via coral farming lies in its potential to alleviate poverty for farmers and boatmen alongside its mitigation of climate change impacts on the lagoon. The project also promotes education about coral reefs. The initiative is a relatively recent development, so a baseline examination will be helpful for future assessments of community impacts.

The menace of climate change produces a number of detrimental consequences which include depletion of marine resources, environmental degradation, and warmer ocean temperatures, each of which directly affects marine economic activities. The feasibility of seaweed production and fishing – two primary income sources for Jambiani residents – is declining. The study of sponge and coral aquaculture and their relationships to participants using the NGO Marine Cultures as a model proves important to address livelihood options in the face of community poverty.

## 2 BACKGROUND

Conceptual knowledge of Marine Cultures, sponge cultivation and coral restoration are integral to understanding the nature of the study and its implications. In addition, information about the Jambiani community provides context for the study.

### 2.1 Key Concepts

Marine Cultures is an NGO that focuses on aquaculture and marine conservation. The organization is especially concerned with the overuse of marine resources and its contribution to poverty. To address this issue, they strive to work in close cooperation with local communities whose governments lack authority and financial resources to alleviate such challenges. Funding is provided through membership fees, donations and grants<sup>2</sup>. With the intent of promoting sustainable and economically beneficial utilization of the sea, Marine Cultures spearheads marine production projects to provide community members with an understanding of economic benefits that accompany sustainable practices, with emphasis on education and capacity building. These initiatives include marker buoy placement in protected areas, conservation awareness and education, coral restoration, octopus management, and monitoring reef resilience. Most relevant to this study are the training course in sponge farming, an operation introduced to Zanzibar by the NGO in 2009, and the coral restoration project, launched in 2014<sup>2</sup>. The one-year sponge farming program instructs women (particularly single mothers) in the cultivation and commerce of sponges, with each participant receiving a sponge farmer certification as well as her own farm<sup>2</sup>. The coral project, in partner-

*Sponge and Coral Aquaculture*

ship with Coral Reef Care, seeks to promote marine conservation while providing an adequate means of income for coral farmers and tour boat operators (C. Vaterlaus, personal communication, Nov. 2019). Farmers are trained in diving and coral care, and boat captains are educated about corals and marine conservation.

Sponges (phylum *Porifera*) are sessile animals that filter-feed on organic particles in the water such as phytoplankton, bacteria and detritus<sup>3</sup>. As their phylum name suggests, sponges have porous structures, with cavities through which water enters in inhalant canals and exits via expulsion<sup>4</sup>. Thousands of species can be found across the globe, in a large variety of shapes and sizes. The diversity and abundance of sponges makes them an integral component of marine ecosystems. Not only do they provide food and habitats for other organisms, but they are key contributors to primary production, nitrification, and water filtration<sup>5</sup>. Not surprisingly, sponges can hold large amounts of water which contributes to their value for people. Sponges are most widely used by humans for bathing purposes, but are also employed as antifouling agents, in antibiotics, as anti-inflammatory/ anti-viral agents<sup>3</sup>, and in various household cleaning contexts. In addition, sponges are utilized in hospitals for cleansing and medicine application, and as natural contraceptives<sup>6</sup>.

Globally, a large market exists for sponges and demand is much higher than supply<sup>6</sup>. Many people prefer real sponges to synthetic products, as they are more effective and aesthetically pleasing. Despite highly variable growth rates<sup>4</sup>, sponge cultivation was presented as a means to meet rising demand and improve uniformity of supply<sup>7</sup>, though farming sponges is documented as early as the late nineteenth century<sup>3</sup>. Sponge cultivation proves suitable for remote coastal communities due to its low-cost materials and local processing<sup>8</sup>. Moreover, sponges sell for high prices, making them a viable source of income. However, most operations are exceedingly small in scale, and 99% of commercial sponges are poached (C. Vaterlaus, personal communication, Nov. 2019). The most common production technique for sponges is the floating raft method, which entails attachment of small sponges to ropes and their suspension using floating buoys<sup>6</sup>. This process is implemented in the shallows just beyond intertidal zones as well as in deeper waters. Deep water farms have been found to be more successful but carry added challenges due to the necessity of swimming proficiency and diving equipment, which is not always possible for villagers<sup>6</sup>.

Corals (phylum *Cnidaria*, class *Anthozoa*) are a highly diverse group of animals found primarily in tropical and subtropical waters that live communally and form reefs. Coral reefs prove exceedingly valuable, as they support a high level of biodiversity which provides food, economic opportunity, pharmaceutical products, and tourist attraction. As a result of anthropogenic

influence, such as overfishing, pollution, and climate change, the world's reefs have been significantly degraded. Corals may be raised for reef restoration, commercial purposes, or drug discovery<sup>9</sup>. In tropical and subtropical areas (i.e. Tanzania), cultivation takes place in the field<sup>9</sup> as opposed to land-based aquariums. This is advantageous because if sites are selected appropriately, costs of maintaining suitable environmental conditions are eliminated. Moreover, coral cultivation has the potential to be beneficial in terms of biodiversity preservation, disturbed reef rehabilitation, and the reduction of wild coral harvest for the curio trade<sup>10</sup>. For growing corals, the cutting method is primarily used, in which 5-10cm pieces of coral, called "nubbins," are cut from mature corals and secured to hard surfaces<sup>9</sup>. Hard corals, which produce calcium carbonate skeletons, are primarily grown since they provide the structure necessary to build reefs<sup>11</sup>. Growth rates are impacted by a number of factors, such as light, water motion, temperature, and nutrient availability. The impacts are species specific which creates added complexity to the cultivation process<sup>10</sup>.

Coral aquaculture or coral farming has been introduced as a means of mitigating loss of coral and providing alternative livelihood options for coastal communities, such as those in Jambiani, Zanzibar<sup>2</sup>. In Madagascar, community-based coral aquaculture was introduced in 2008 to fishermen without alternative livelihoods to fishing. The project was deemed economically and environmentally feasible for small-scale village operations<sup>9</sup>. Similarly, the relatively recent establishment of the coral project in Jambiani is promising in that it addresses the likelihood of decreased profitability of fishing in the years to come.

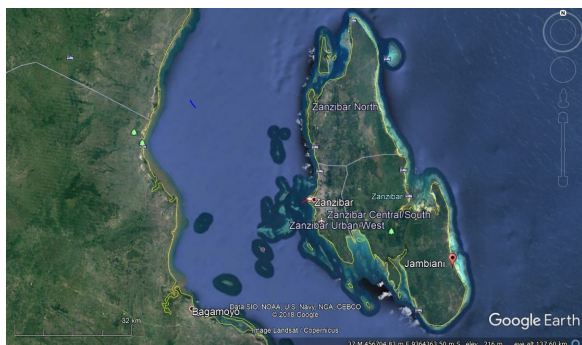
## 2.2 Study Site: Jambiani, Unguja, Zanzibar-Tanzania

Unguja is the largest island in the Zanzibar Archipelago in the United Republic of Tanzania in the western Indian Ocean. As a result of relatively recent historical colonial rule, Zanzibar lacks a diversified economy necessary for economic development, with most income generated from tourism and fishing. Much of the island's population subsists on the equivalent of approximately \$1 USD per day. The primary language spoken in the Archipelago is Kiswahili, which is important given that interviews were a major component of the investigation (see Methods). The location of the study was Jambiani, a collection of villages measuring 70 km<sup>2</sup> in area<sup>11</sup> with 10 km of shoreline<sup>6</sup> on the eastern coast of Unguja, approximately 40 km southeast of Stone Town. It is situated south of Paje and north of Makunduchi.

Jambiani is comprised of five villages in a line, which from north to south are Kibigija, Bahani, Mbuyuni, Mwinyiwagogo, and Kikadini. All five villages were

represented by interviewees whose homes were visited. The population of Jambiani continues to increase, which exacerbates issues related to income as well as strain on marine resources. The population is approximately 9,000 people<sup>1</sup>, about 52% of whom are women<sup>12</sup>. Seaweed farming is one of the primary economic opportunities for women in Jambiani; on a given day it is possible to see 300-400 women out at work (C. Vaterlaus, personal communication, Nov. 2019). However, its feasibility and sustainability have lately decreased due to warming ocean temperatures and product price reduction<sup>13</sup>. In response, the production and sale of sponges provides an alternative means of economic support to individuals and families struggling to meet basic needs, especially since sponges are relatively tolerant of warmer temperatures. Though they are fairly resistant, warming associated with climate change can increase sponges' vulnerability to disease and inhibit growth<sup>3,7</sup>, which would jeopardize the recent cultivation developments. Many men in Jambiani are fishermen, which is no longer a sustainable source of income due to depleted fish stocks from reef degradation and overfishing. Thus, coral farming and tour boat operation to view coral restoration provide alternate livelihood options that also assist with the mitigation of climate change impacts.

Studies were conducted at Marine Cultures headquarters, in the village and in the coastal waters where the sponge and coral farms are located. Jambiani was selected as the most logical study site given that Marine Cultures and its marine projects are based in the village and lagoon. Being located in Jambiani was not only essential to observe the sponge and coral farms, but also provided opportunities for in-person conversations with Marine Cultures staff, female sponge farmers, men involved in the coral project, and other community members whose input was invaluable to this study.



**Figure 2.** Google Earth image that depicts the location of Jambiani on Unguja, Zanzibar-Tanzania.



**Figure 3.** Image of Jambiani coast, which is utilized extensively by local residents and tourists.

### 3 METHODS

The methods employed were interviewing and participant observation. Slightly different strategies were used for interviewing Marine Cultures staff, sponge farmers, neighbors and men involved in the coral project. Primarily observation was utilized for the corals. Informal interviews and dialogues also assisted in data collection.

#### 3.1 Interviews of Marine Cultures Staff

Semi-structured interviews were held with Christian Vaterlaus, the managing director and Okala Mohammad, the former project manager of Marine Cultures. Each individual was in a position to provide extensive information about the nature and narrative of the organization's history. Questions were posed (see Appendix 1) that focused on the story of the NGO, specifically its history, mission, role in the community, successes, challenges and goals, with follow-up questions based on the answers provided. The semi-structured format was selected due to a desire to gain specific information without limiting the scope of responses as well as to account for the possibility of interviews being conducted simultaneous to other activities such as introduction to the farms. Handwritten notes were taken for later analysis and development of a timeline of the NGO. Mohammad's interview was approximately 90 minutes in length and Vaterlaus's was about 80 minutes in length. However, many questions were answered by Vaterlaus and Connie Sacchi, a Marine Cultures Associate, during conversation throughout the study period.

#### 3.2 Participant Observation of Sponge Farming

Sponges and the nature of sponge farming were studied via participant observation to better understand the farms and their operations. The formal definition of participant observation is "discovering through immer-

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sion and participation the hows and whys of human behavior in a particular context”<sup>14</sup>. Participant observation was selected in order to gain a multi-dimensional comprehension of sponge farming through the combination of factual information and sensory experience. Moreover, the extensive time involved in participant observation enabled thorough data collection. The process involved engagement with Marine Cultures staff in addition to female sponge farmers. Activities included cleaning, trimming, planting, harvesting, and processing sponges as well as cleaning ropes. The deep-water nursery farm was also observed on one occasion (see Method 4). Data was collected in the form of written observations after return from the sea and pictures were taken to serve as visual aids. Study of the farms began during the first week of the study period, since an understanding of sponge cultivation was desired before the investigation of Marine Cultures and interviews with sponge farmers. Five time periods of approximately three hours were used for data collection. Informal interviews with Ali Mahmudi and Ali Pandu occurred alongside the participatory activities, in addition to brief dialogues with the women. Interviews with farmers began before the completion of participant observation out of convenience.

### 3.3 Interviews of Female Sponge Farmers

Ten active sponge farmers were interviewed formally to gain insights into the nature of sponge farming and its impacts. Interviews were structured due both to a language barrier and the pursuit of precise information about the lives of the women. This process took place during the beginning of second week of the study period and continued through the third week. Prior to asking questions, a brief introduction was provided to explain and give context to the study. Each interview was conducted with the assistance of a translator due to lack of fluency in *Kiswahili* and interviewees were given the opportunity to ask their own questions so as to avoid confusion about the project. Interviews were approximately 30 minutes in length. When possible, interviews were recorded to facilitate precise quotations and to limit the need for follow-up interviews. Questions (Appendix 2) addressed each woman’s role in sponge cultivation, how and when she became involved with Marine Cultures, ideas about the impacts of farming on her life, her responsibilities besides sponge farming, and how farming integrates into her life on a daily basis. In addition, three farmers were selected for further interviews based on their availability and recommendations. Their answers were used in the creation of biographical sketches (shorter and more specific versions of biographies) for each of the women interviewed. Responses from all interviews supplemented participant observation for discussion of how sponge cultivation impacts

women in Jambiani.

### 3.4 Observation of Coral Farm and Deep-water Sponge Nursery

A boat was taken to view the sponge nursery, coral growth operation, and the house reef currently under restoration. Reef balls, coral cleaning, checking of nursery sponges, placing of coral tables, and the status of the house reef were observed in a single outing. Participation was not possible given an inability to dive per SIT policy, therefore data was collected via snorkeling. However, swimming down to observe was possible given that depth did not exceed 10 m. Pictures were taken to serve as visual aids. The observation period included a brief dialogue with Rolf Voorhuis, founder of Coral Reef Care. This exchange was integral to understand the reef restoration initiative in Jambiani lagoon.

### 3.5 Coral Project Interviews

Three coral farmers and one boat captain were interviewed about the coral restoration project. Interviews were structured, assisted by a translator when necessary, and lasted approximately 25-minutes each. Interviews were conducted individually, but all interviewees were present. Questions for the coral farmers (Appendix 4A) concentrated on the nature of the job and the benefits in terms of skills and income. In addition, inquiries were made about each individual’s life to be used in the creation of a biographical sketch, based on the interviewee that provided the most thorough information. For the boat captain, questions (Appendix 4B) focused on the Chumbe training, the value of the job, and marine conservation. Only one boat captain was interviewed due to a lack of availability.

### 3.6 Interviews of Jambiani Neighbors

Based on sponge farmer recommendations, four women in the community who are not farming were interviewed in an effort to gain insights regarding awareness of Marine Cultures and their aquaculture projects, perceptions of the overall operation and why they do not participate (See Appendix 3). Interviews were structured, assisted by a translator when necessary, and were approximately 30-minutes each. One young man was also briefly interviewed about his awareness of Marine Cultures and the cultivation of sponges and corals. Questions were posed in and around the homes of interviewees out of convenience and to maximize comfort for interviewees. Interviews were utilized because they are the most direct method of obtaining individual responses.

## 4 RESULTS

Interviews and conversations with Marine Cultures staff were used in the creation of a timeline that depicts the organization's history. The timeline serves as a launching point for discussion of aquaculture, NGOs and community influence. Participant observation provided substantial information to develop an understanding of sponge cultivation in terms of the processes involved, technical knowledge required, challenges, and sensory experiences. Sponge farmer interviews provided insights into the benefits of sponge cultivation and its integration into the lives of women in Jambiani. Furthermore, the interviews enabled the creation of three biographical sketches. The observations of coral restoration proved informative with regard to the implementation of coral farming in the Jambiani lagoon. Interviews with coral farmers were beneficial to understand the nature of the project and advantages of the job, in addition to the generation of one biographical sketch.

### 4.1 Marine Cultures Narrative

A timeline (Table 1) was constructed to depict key events and milestones for Marine Cultures from its establishment up to the present, including desired future outcomes. Data was integrated from interviews, informal dialogue with the staff in the organization, and annual reports.

After years of traveling away from his home in Switzerland, Christian Vaterlaus decided to explore the possibility of living abroad. He and Connie Sacchi visited Zanzibar several times, eventually building a house on a property in Jambiani to comply with the government. They saw the poverty, declining marine health, and the decreasing feasibility of coastal activities such as seaweed production (C. Vaterlaus, personal communication, Nov. 2019). A new and sustainable practice was necessary; Marine Cultures was born in 2008 as a result of a desire to work alongside the community to address oceanic and socioeconomic issues, with aquaculture being at the intersection of the two. Aquaculture not only makes products that can be sold to generate income, but it also leads to conservation because people are motivated to care for the sea (C. Vaterlaus, personal communication, Nov. 2019). Christian found Okala Mohammad, head of the NGO Jambiani Marine and Beach Conservation (JAMEBECO) and the two discussed ideas, eventually developing the sponge project together (O. Mohammad, personal communication, Nov. 2019).

Cultivation of pearl oysters was explored, but ultimately sponges were selected as the focus due to the ability to operate with relatively simple equipment. From 2009 to 2012, sponge experimentation took place

in collaboration with several research institutes. The process included the identification of 140 species, the exploration of biomedical applications and a thorough evaluation of the market potential (C. Vaterlaus, personal communication, Nov. 2019). This was a difficult task. For example, one species grew well for 3 years, but could not produce brood stock and therefore could not be grown sustainably. Eventually the *Callyspongiidae* family was selected for growing common bath sponges.

### 4.2 Participant Observation of Sponge Farming

The majority of work in the cultivation of sponges takes place around the full and new moons in the lunar cycle. When the height of the low tide is less than about three-fourths of a meter, the coastal waters are shallow enough to conduct work. The women go out to the farms during the low tide, usually four days before and after new and full moons and spend two to three hours each day tending to the sponges, but sometimes up to six hours in a day. Required equipment includes tools (bike chain, knife, and dead sponge), mask, snorkel, dive boots, fishing lines, and a bag or *kanga* to collect green algae. The farmers prepare together, suiting up, gathering equipment, and sharpening their knives. Returning from the farms involves showering and cleaning and organizing their daily equipment.



Figure 4. Sponge Farmer 1 and project manager inspecting sponges.

Planting begins in the deep-water nursery, where large sponges are grown and cut to start new farms, with the seedlings growing below (Figure 5). To plant,

**Table 1** Timeline depicting key events in the history of Marine Cultures

2008	Establishment of Marine Cultures NGO
2009	Sponge farming introduction to Zanaibar, exploration and research began
2012	Discovery of sponge species that can be trimmed to make seeds - <i>Calyspongiidon</i>
2014	Started growing corals for aquarium trade
2015	Had to abandon unproductive sponge farm in Mtende, began growing coral for aquarium trade
2016, May	First two women became independent sponge farmers, great year for production
2016	Spread to Mafia with Chole marker buoys, noticed by foreign NGOs, media coverage increased visitors
2016	El-Nino destroyed >50% reef and coral project
2017	More bleaching and destruction of coral project, shifted focus to resistant corals, restored 1 <sup>st</sup> bit of reef with 300-400 corals
2017, Dec	All 10 sponge farms sustainable, no more wild sponges needed
2018	Sponges suffered from brittle star epidemic
2019	Bahari Salama film produced, focusing on marine conservation/ aquaculture in Jambiani
2019, Fall	Worst case of green algae fouling on sponge farms ever experienced, moved into new office building
2021/2022	Sponge farming 100% community owned

a clean plastic wire is run through the center of a round sponge, tied in a loop and attached to the rope by pulling the sponge through the loop. Sponges are checked for growth of cyanobacteria, algae, and invertebrates during each farm visit. The shaping of sponges is done with a utility knife and fouled, or protruding pieces, are removed to form a clean round shape. Precautions to minimize sponge deaths include not squeezing sponges and never cutting pieces bigger than one-third of their body sizes. Sponges are cleaned by hand or with a dead sponge to carefully remove algae, invertebrates, or other particulates that may increase mortality. To clean the ropes, farmers vigorously scrub them with a bike chain to remove thick algae coatings. Cleaning does not happen every day since time is limited and there are thousands of sponges. Since it would be impossible to address each and every sponge each day, farms have “special care” lines, where promising sponges are placed for a few months to a year so as not to overlook them. The special care sponges are checked and cleaned more thoroughly than the remainder to maximize their selling potential.

When aesthetically pleasing sponges are large enough, they are harvested which entails taking them off the line, squeezing and rinsing them in the ocean, and collecting them in mesh bags. Harvested sponges undergo an extensive cleaning process, in which farmers wash sponges twice with harita (a natural soap) while carefully picking out shells and debris. Sponges are then placed in an acid solution for 20 minutes (Figure 6) followed by a powder-water mix for about 1



**Figure 5.** Deep water sponge nursery (left) and planted sponges (right).

minute. After rinsing, farmers again wash the sponges with harita, squeeze them and let them dry. The process is repeated, if necessary, to remove odors and foreign objects. Quality control is strict, and inadequate sponges are discarded. They are sold for either \$25 or \$30 USD, depending on the size and the quality, and farmers take them to shops around the island to be sold.

The primary challenge during the observation period was a plague of green algae, known as *majani*, that attaches to sponges and suffocates them (Figure 7). This time was particularly problematic, likely due to heavier than average seasonal rains (C. Sacchi, personal communication, Nov. 2019). A large portion of participant observation involved removing *majani* from sponges and ropes and taking full bags of it away from the farms. Other observed difficulties include navigating around massive urchin clusters, wind and wave action, rain and cold water, operating at the mercy of tides, fatigue, and, unfortunately, the death of sponges (Figure 8).



**Figure 6.** Sponges soaking in acid and water solution during processing.



**Figure 7.** *Majani* (green algae) covering sponges and ropes.

### 4.3 Sponge Farmer Interviews and Biographical Sketches

Of the ten farmers interviewed, seven previously cultivated seaweed and said that sponge farming is much better than seaweed farming since profits are higher and labor is less intensive. Other prior jobs mentioned included housekeeping, small trade, agriculture, and the collection of firewood. Almost all interviewees reported that they heard about Marine Cultures from other people, whether villagers, Marine Cultures staff or other farmers in the area. The few remaining interviewees either forgot or did not provide an answer to the question. Previous experience farming ranged from a little over one year up to six years.

Four interviewees specifically stated that other means of income generation were not necessary to supplement the sale of their sponges. Nearly all interviewees relayed that they participated in small trade activities, such as selling *chapati* (a flat bread) or *kofia* (embroidered hat), but no other significantly demanding jobs were reported. Outside of sponge cultivation the primary responsibilities mentioned for the sponge farmers were as follows: childcare, food preparation, household chores,



**Figure 8.** Large urchin cluster (left) and dead sponge with evidence of algae and cyanobacteria, as well as a brittle star living inside.

firewood collection, small farm operation, sewing *kofia* and errands (i.e. to Stone Town). Only one farmer expressed difficulty with balancing sponge farming with her other responsibilities, and a majority of interviewees cited effective time management as the reason for their ability to accomplish all activities each day.

All of the farmers interviewed explained the economic benefits of sponge cultivation and noted that it enabled the successful achievement of their goals or dreams. Five interviewees specifically mentioned that sponge farming enables them to cover basic needs, five mentioned its role in caring for their children (especially paying for school), and five described its assistance in home upgrades or construction. The purchase of other goods such as a refrigerator to start a juice business and furniture purchases were also attributed to income generated from sponges. Independence was also cited as a positive outcome of sponge sale by about half of the farmers, as they appreciate the freedom to run their own lives. Only two farmers did not view independence favorably due to the added pressure to succeed that accompanies self-employment.

When asked how others perceived sponge farming, responses focused on the achievements whether out of curiosity, excitement, or jealousy. Five women said that people see the sponge farming as comparable to other economic activities and one woman stated, “*At first people saw us differently because we quit seaweed farming. They thought we were wasting our time until they saw the benefits, now they see it favorably like other jobs*” (Sponge Farmer 1, translated). A handful of sponge farmers mentioned that people thought it was unusual for women to swim and were therefore unsure what to think about the job. Ideas about how men perceive sponge cultivation varied considerably. Some said men think farming is easy, others that men think it is too difficult for women. A few felt that men are indifferent, and one said that men say to continue because of the benefits to women and their families.

Six women explicitly stated that they would like to have more sponge farmers so that more families could receive the benefits. Only one expressed moderate concern for the added complexity of farming with additional people. In addition, one farmer remarked, “*More*

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farmers would be beneficial because different people have different skills, talents, and ideas that could be utilized to assist one another” (Sponge Farmer 7, translated). Four women had neutral or no answers about the number of farmers. When asked what they would tell people who aren’t farming, eight women said they would explain the cultivation process and benefits in their lives.

Interview responses enabled the creation of three sponge farmer biographical sketches: Aysha Said, Fatima Mohammad and Latifa Salim. Each brief biography depicts an abbreviated life history with emphasis on the impacts of sponge cultivation. Pseudonyms were created for privacy purposes; the author has original names.

### 4.3.1 Aysha Said

Aysha was born in Zanzibar City (Stone Town) and lived there with her parents. Her parents passed away when she was young, so she went to live with her grandparents in Bambi (central Unguja). She finished school there, then moved to Jambiani where she was married and gave birth to four children. Aysha and her husband divorced, so she lived as a widow for six years and during that time was recruited by Marine Cultures to become the first sponge farmer. She has been cultivating sponges for six years and operates independently. Prior to sponges, she was a seaweed farmer, and says sponges are a significant upgrade since she can provide for basic needs, pay school fees for her kids, and does not need to do other activities to generate income. Aysha remarried two and a half years ago, and now lives with her husband and two kids in Jambiani Kibigija.

Depending on the tide and status of her farm, Aysha typically spends two to three hours but up to six hours working during the eight to nine days surrounding full and new moons. Outside of sponge farming, she balances a number of other responsibilities, including taking care of her children, cooking, cleaning, and collecting firewood. She says that using time effectively is the key to managing everything. When she has free time, Aysha enjoys being in her home either doing domestic tasks or making small trade items such as *kofia* and has also developed skills as a dress designer.

Aysha is immensely humble, but one thing of which she is proud is being a sponge farmer because she has the capability to run her life without reliance on others. She would like to be known for being a skilled swimmer someday and is working hard to reach that goal. One moment in her life she says she will never forget was when she almost drowned in the ocean. Aysha offers advice she has learned that “Changes can come at any time, so one has to adapt and be dynamic” (Said, translated).

### 4.3.2 Fatima Mohammad

Fatima grew up in Jambiani with her three brothers and seven sisters. She has always lived in Jambiani and her



Figure 9. Aysha Said

family is there, too. After completing her studies, she was married and had two daughters before she and her husband divorced. After the divorce, she had another child who is still a baby, and currently lives with her three children. Fatima likes sponges and has been cultivating them for three years now. When asked about something of which she is proud, Fatima replied, “I am proud to be a sponge farmer because I have the ability and economic means to run my own life. I enjoy not needing to rely on others to support myself and my children” (Mohammad, translated). Fatima says she has already benefitted a great deal from sponge farming, since she has been able to buy furniture and send her daughters to school in addition to adequately covering basic needs. Plus, she is currently in the process of finding a place to build her new house.

Fatima’s favorite food is *chipsi* (French fries) and can be found sewing in her free time, as she truly enjoys making *kofia*. She says free time is when she is not working on the sponge farm, since that is her daily activity and otherwise, she would have to say she does not have free time. Outside of sponge cultivation, she is responsible primarily for childcare, especially since she has a baby to look after. She also cooks and runs her household and like other farmers balances everything with effective time management. One significant event that Fatima says she will never forget is when someone stole a large amount of money from her house. She struggled



Figure 10. Fatima Mohammad

to recover from the loss.

#### 4.3.3 Latifa Salim

Latifa has lived in Jambiani since she was born, growing up and completing her studies in Jambiani Bahani. She has three siblings: two brothers and a sister. Latifa has two children, one son and one daughter. Currently, she lives with her husband and one of her children. Her other child lives with a grandmother. She takes full responsibility of her children and balances parenting with sponge farming with efficient time management. During her free time, Latifa chooses to rest, especially after working in the sea. Her favorite dish to eat is rice with roast sauce.

Prior to cultivating sponges, Latifa was a seaweed farmer and collected shells on the beach to sell. She heard about Okala and his work on the island before she heard about Marine Cultures because people were saying that women were diving there, which was surprising to her. She was given the opportunity to join the sponge farmers after someone told her about the job, answering her questions to remove misconceptions. She was intrigued and has now been farming for three years, operating independently. One thing Latifa would tell others about sponge farming is the reality of the work required with explanations of the processes involved. She says, *“People see the difference sponge farming has made in my life because of my achievements, for example obtaining land to build a new house which I previously could not do”* (Salim, translated).



Figure 11. Latifa Salim

Latifa will be proud when she has her own house, the construction of which is being funded by income generated from selling sponges. She says she has learned a lot in her life, but the biggest lesson is adaptability. Since times always change, one has to be ready to learn new things. For example, collecting shells used to be a good source of income for Latifa but when that was no longer feasible, she had to learn something new to support herself and her children. In this case, that thing was sponge farming.

#### 4.4 Coral Restoration Observation

Corals are grown on about 40 tables on the sea floor in the Jambiani lagoon with the purpose of restoration and response to damage as a result of climate change. Marine Cultures partners with Coral Reef Care, a Dutch NGO focused on protecting and rebuilding reefs. To begin, “corals of opportunity” - or pieces naturally broken for example by boats or storm - are attached to cement pieces and placed on tables (Figure 12). After three to eight months, the cement plugs are inserted into reef balls to create an artificial reef or attached to substrate to repair the adjacent house reef (Figure 13) which was 90% destroyed by El-Nino in 2016 (C. Vaterlaus, personal communication, Nov. 2019).

Managing the coral farm includes moving tables, cleaning corals with small brushes, scrubbing tables,

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Figure 12. Small corals “planted” on tables.



Figure 13. House reef that is under rehabilitation in the Jambiani lagoon.

and monitoring coral health (Figure 14). Due to the seafloor location in relatively deep water, diving equipment is necessary for maintenance which creates significant expense and safety considerations. In addition, operating machinery has the potential for injuries such as cut fingers and working in the ocean means the possibility of harm from marine wildlife. Farmers typically visit the corals four times per week for a few hours each time.

#### 4.5 Coral Project Interviews and Biographical Sketch

Prior occupations of coral farmers included as a cook, dive shop employee, and farmer, in addition to the common occupation of fishing. Interviewees reported no need to do other activities for income generation. Two out of the three coral farmers interviewed said that support of their parents was a primary benefit of their job, with the third mentioning that he was able



Figure 14. Divers inspecting and cleaning nursery corals.

to care for his wife and five children that rely on his income. Other advantages to coral farming included skills such as diving and technical knowledge, materials for home construction, and the freedom to purchase items beyond basic necessities.

The predominant challenge explained was the potential for minor injuries. One farmer relayed that he “got a stick in [his] stomach once, and another time hit [his] head” (Coral Farmer 2, translated). Another farmer mentioned that he occasionally cuts his fingers and that using tools yields accidents. Also, diving each day can be difficult for logistical reasons as well as fatigue.

Two farmers noted that people see the coral project as comparable to other jobs and one said people are uneasy because they think the job is too dangerous. To those unsure about joining, the farmers would say that it is a good job and explain their daily activities. One farmer elaborated, “[coral farming] is not only important for personal benefit, but for the community and for environmental conservation” (Coral Farmer 2, translated). The farmers and the boat captain all spoke about the necessity of conservation in the Jambiani lagoon, for instance, one argued, “Coral restoration is a good job because conservation is important and having more corals will attract more tourists in the future and therefore increase income” (Boat Captain, translated). Conservation was also a reason cited for a desire to see more coral farmers and boat operators, in addition to increasing the efficiency and the effectiveness of the reef restoration project.

Interview responses were utilized to create one coral farmer biographical sketch for Juma Ali Omar. The sketch depicts a brief history with a focus on coral farming. A pseudonym was created for privacy purposes, the author has the original name.

##### 4.5.1 Juma Ali Omar

Juma was born in Makunduchi (just south of Jambiani) and raised in Jambiani, with four sisters and one brother. His first jobs were fishing and farming. He started

working with Marine Cultures about six years ago. He was interested in marine work given his fishing background and was curious about planting sponges and corals. Juma continues to fish occasionally and helps his parents plant crops such as cassava, but being a coral farmer is an adequate source of income for him. Juma says that the primary benefits of his job are the ability to support his parents and other family members in addition to having the capital necessary to buy building materials for his house. Also, he has a number of skills including diving, knowledge of corals, sponges, and the cultivation of each, using power tools, fixing tables and swimming. He is proud to own his own house as well as a motorcycle.



Figure 15. Juma Ali Omar

In a typical day of work, Juma spends up to five hours completing tasks such as planting corals, moving tables, cleaning corals, and repairing equipment. He says one challenge of the job is that using tools can result in accidents such as cut fingers. Juma would like to have more coral farmers so that more of the reef damage can be mitigated. He thinks that community members view his work like any other job but in reality, it is special because it has a broader goal of restoration, and the results cannot be seen day to day since coral grows slowly.

In his free time, Juma likes to learn about marine environments, corals, and sponges on the internet to be better informed. He thinks about how to improve the efficiency and effectiveness of his daily work. One experience he will never forget is his first time traveling by plane, which felt as though he was dreaming, and it was an opportunity provided by Marine Cultures. Juma cites his favorite foods as being cassava, *njugu-*

*mawe* (white bean/ ground nut), and *viazitona* (potato dish). The most important lesson he has learned from the challenges of others is to work hard, doing whatever it takes to avoid unemployment and the resulting difficulties.

#### 4.6 Jambiani Neighbor Interviews

Two of the interviewees were young women, one a middle-aged woman, one an older woman, and one a young man. All of the interviewees expressed an awareness of Marine Cultures, reported knowing at least two sponge farmers, and mentioned their familiarity with seeing farmers as they walked to and from work. Each person interviewed articulated an interest to learn more about Marine Cultures and sponge farming, with the exception of one woman who knew a great deal from previous experience. Two individuals visited farms once, two had never visited farms, and one tried sponge farming but had to quit due to health complications. Only one interviewee reported not speaking with farmers to answer questions about the job and its potential benefits. One hundred percent of respondents said they would like to become sponge farmers if possible, generally citing economic benefit or poverty alleviation as their reasoning. Awareness of the coral restoration project was minimal; two interviewees had never heard of it, two had a vague awareness of fishing bans or people interested in protecting the reef, and one had seen people diving near the reef. Only two individuals expressed interest in learning more about the coral project.

## 5 DISCUSSION

Based on interview responses and participant observation, sponge farming significantly impacts the lives of women in Jambiani, and the most obvious benefits are economic. The growth and sale of sponges enables mothers to adequately provide for their families which is especially profound for divorced or widowed women. Evidence lies in the conveyed abilities to invest in home improvements, afford school for children, and account for personal needs.

A noticeable social benefit was also observed. The farmers have created their own micro community, which is evidenced by frequent talking, joking and laughing especially during work at the farms. This camaradery could be the result of extensive shared experience in sponge cultivation, former friendships, mutual ties to the community of Jambiani, or any combination of the three. However, it is important to note that social relationships were not studied in depth, and farmers did not directly mention friendships when speaking about positive outcomes of sponge farming.

In addition, participation in sponge farming develops a number of valuable skills that may otherwise not

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have been acquired, and that possess the potential to be applied to other economic pursuits. For example, knowledge of how to swim is uncommon for women in Jambiani. Swimming ability not only mitigates mobility challenges in traveling to and from the farms but could also be useful for other marine activities. Plus, knowledge of cultivation processes could potentially be useful for other aquaculture endeavors, for example the new sea cucumber and shellfish project under development. The development of communication skills is evident given that many interviewees referenced telling others about how to grow sponges and how it has changed their lives. Moreover, the capability to explain sponge farming builds confidence. Women are completely responsible for selling their sponges, so they develop a detailed understanding of business practices, specifically marketing, management and communication; this will be particularly useful when the project is run as a co-op independent of Marine Cultures. Such skills are valuable in any economic setting, so if sponge farming were to become impractical, women would be equipped to pursue other modes of income. Whether or not farmers are aware of the value of their skills was unclear.

Neighbor interview responses offered a small amount of insight into potential reasons for people not cultivating sponges. For example, one interviewee expressed a lack of interest in the sea, which could be true of a number of other Jambiani residents as well. Also, many dialogues and a few interviews indicated that some people are afraid of the ocean or discouraged by their inability to swim. Moreover, most of the neighbors stated that they are satisfied with their current jobs, so it may be that some individuals do not see a need to pursue new economic opportunities. However, only a handful of community members were interviewed, and all of them were friends or family of sponge farmers, so data is realistically insufficient in depicting community attitudes of aquaculture. Also, since the coral project is a relatively recent development and involves a select few people, awareness of the operation was minimal and thus interest levels could not be assessed. In reality, the most likely cause for lack of participation in aquaculture (specifically sponges) lies not within the community of Jambiani but on the Marine Cultures side of the operation, by no fault of theirs. Funding comes primarily from membership fees and grants, which can fluctuate and obviously are not infinite. Plus, thousands of sponge seeds are needed to start a new farm and harvesting them from the wild would oppose the commitment to environmental sustainability. Also, the addition of more staff to run the project would prevent the managing director from being able to be “on the ground” working alongside community members since more management of people would be required (C. Vaterlaus, personal communication, 2019).

The coral reforestation initiative holds a great deal of

promise. Interview results indicated that coral farmers are quite enthused about the job itself, the skills they have learned and the knowledge they have gleaned. Their awareness of the importance of conservation is likely a result of their training by Marine Cultures, since sustainable management of the sea is one of the key components of their mission. The interview results pointed to a broader sense of the significance of the coral project, since the benefits to the community and the environment were emphasized in addition to personal gains. While only one boat captain was interviewed, his responses suggest that the Chumbe training and tour boat operation will be a promising source of income and prove important in the broader context of conserving marine resources.

Marine Cultures exists as an example of a successful NGO in Zanzibar. Primary evidence lies in the fact that women farming sponges as well as coral farmers can speak to tangible benefits as a result of the organization’s efforts. While it is fairly common for European NGOs to be successful in facilitation of progressive community change as a result of higher education and resources, it is not as common to address the measures necessary for impacts to last beyond the organization’s presence in the community. In order to do so, knowledge beyond technical skills such as writing proposals, obtaining materials, budgeting, and finding sponsors must be shared with local residents, especially given that foreigners tend to eventually leave (O. Mohammad, personal communication, Nov. 2019). The initiative to have sponge farming be 100% community owned in the next three years demonstrates the pursuit of solutions by Marine Cultures that are actually sustainable long after the NGO is no longer in Jambiani. If and when it happens, it may be that eventually more farmers could be involved since the operation would ideally be self-sustaining. From the perspective of the women this would be beneficial, since most stated that they wanted to see more people involved in sponge cultivation.

While Marine Cultures operates on a relatively small scale in terms of personnel, the impacts on community members are significant and deserve to be recounted. The ability of staff to be “on the ground” working alongside community members is a component of the organization’s mission, allows for ease of management (C. Vaterlaus, personal communication, 2019), and enables the formation of intentional and intimate relationships.

## 6 CONCLUSION

Aquaculture exists as an influential and productive means of income for coastal communities facing climate change and resource exploitation. In Jambiani, Marine Cultures successfully addresses the intertwined issues of poverty and decline of ocean health via the establishment of sponge farming and coral reforesta-

tion. This study analyzed the influence of aquaculture on community stakeholders, primarily with respect to sponge cultivation and secondarily in regard to coral farms. The principal aim was to investigate the impacts of sponge farms on the lives of women through a case study of the NGO Marine Cultures in Jambiani, with supplementary examination of the coral project and potential for community benefit. Through participant observation and interviewing, a narrative of Marine Cultures, four biographical sketches, and a representation of how aquaculture benefits Jambiani residents were generated.

Depletion of marine resources, environmental degradation, and warmer ocean temperatures as a result of climate change prove detrimental for the marine economic activities, specifically seaweed farming and fishing. Jambiani is not alone in its struggle to develop sustainable economic opportunities for a growing population as the earth's natural processes shift from anthropogenic influence. Thus, this study of sponge and coral aquaculture and their relationships to participants via the case study of Marine Cultures NGO proves important in terms of livelihoods in the face of poverty for coastal communities.

## 7 RECOMMENDATIONS

In order to maximize the effectiveness of the study, communication and planning with Marine Cultures prior to project development would be beneficial. In addition, more extensive collaboration with the translator for question generation and more knowledge of *Kiswahili* may have produced more detailed results from interviewees. One of the primary limitations of the study was that ample answers to all questions were not obtained from all interviewees. This was likely due to a language barrier, specifically insufficient knowledge to generate effective follow-up questions.

Future research should include a more randomized selection of Jambiani residents to provide insight into community awareness and opinions of sponge cultivation, as well as more completely gauge the level of interest community members have to participate in aquaculture activities. Since only a handful of neighbors were interviewed and all were acquaintances of sponge farmers, the results could only provide a glimpse of why people are not involved. Further, awareness of Marine Cultures and aquaculture projects were likely much higher than other people in Jambiani and therefore was not be an accurate representation of the village as a whole.

In the years to come, examination of Marine Cultures should occur to add to the narrative, investigate how community influence has changed, and whether or not sustainability has been maintained. In particular, the effectiveness and impacts of the reef restoration project

should be evaluated since the project is a relatively recent initiative.

Knowledge of Marine Cultures, its successes, and impacts on aquaculture participants are beneficial for other NGOs with similar interests in sustainably and alleviating poverty. The results of this study exist as a model for establishment that includes anticipation of challenges and a framework for implementation. Moreover, the information generated about aquaculture – technical knowledge as well as stakeholder benefits – is a resource for coastal communities facing similar problems around the world. This study provides support of development of other aquaculture projects in the Zanzibar Archipelago, since environmental and socioeconomic sustainability work together successfully.

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## 9 EDITOR'S NOTES

This article was peer reviewed.

## 10 APPENDICES

### 10.1 Appendix 1: Interview Topics for Marine Cultures Staff

#### 10.1.1 *Christian Vaterlaus, Managing Director*

1. What was the initial motivation for the establishment of Marine Cultures? Has the mission changed at all over the years?
2. What were the primary challenges of establishing an NGO in Zanzibar?
3. How did you go about introducing sponge farming to Jambiani? Why was Jambiani chosen?
4. Significant milestones in journey of the organization? (Key successes/challenges)
5. What is the connection between Switzerland and Zanzibar? Do you find any obstacles in terms of community attitudes, since MC is not originally from Zanzibar?
6. How does Marine Cultures compare to other NGOs in Zanzibar?
7. How are funds managed/ budgets created from

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donations/membership fees etc.?

8. What advertising is implemented to promote members joining? Where are most of the members living?
  - (a) Do they visit MC or observe the projects?
9. Describe relationships with community members and partners and how they were established.
10. What does an NGO need to do to be sustainable after it leaves?
11. Has MC expanded recently? Why or why not?
12. What are some important lessons learned? Current challenges?
13. What are your goals for the future of the organization?

*10.1.2 Okala Mohammad, former Project Manager*

1. How and why did you become involved with Marine Cultures and how long did you work there? Why are you no longer working with them?
2. Describe history/story of establishing sponge farming in Jambiani.
3. What were the primary challenges and successes?
4. What was your original motivation to become involved in the sponge farming project?
5. What types of partners does Marine Cultures have and how do they work together? In your opinion how aware of MC and sponge farming are residents of Jambiani? Are tourists aware of NGO activities in Jambiani?
6. Has Marine Cultures grown in the past several years? Why or why not? How are the projects advertised, particularly to potential members? How are sponges marketed? How are funds and budgets managed?
7. In your opinion, how does an NGO get community participation?
8. What does an NGO have to do to be sustainable? How can it make a difference even after it leaves?

**10.2 Appendix 2: Interview Questions for Sponge Farmers***10.2.1 General, for all farmers interviewed*

1. Describe the activities of a typical day.
2. When and how did you hear of Marine Cultures?
3. How long have you been farming?
4. What did you do before cultivating sponges? Do you continue?
5. Do you participate in other activities to generate income?
6. What are your responsibilities outside sponge farming? Is it difficult to balance them?
7. How much time do you spend each day you visit the farms?

8. How does farming benefit you? Is there social benefit? Are there useful skills you've learned?
9. What are the challenges of sponge farming?
10. What do men think about farming? Do you think they see you differently? Is it good to be independent?
11. What would you tell people unsure about starting to farm? Would you like to see more farmers?

*10.2.2 Follow-ups for bio-sketches*

1. Where did you grow up and how many siblings do you have?
2. Who do you live with now?
3. What do you like to do with free time?
4. What is something people should know about you?
5. What are a few significant events in your life?
6. What are some things you are proud of and why?
7. What is one important lesson you have learned?
8. Favorite food?

**10.3 Appendix 3: Coral Project Interview Questions***10.3.1 Coral Farmers*

1. When and how did you hear of Marine Cultures? How long working with corals?
2. What did you do before corals? Do you continue?
3. Do you participate in other activities to generate income?
4. What are your responsibilities besides growing corals?
5. How often do you visit the farm?
6. How does coral restoration benefit you? Most useful skills?
7. What are the biggest challenges?
8. What do other people think about your work?
9. What would you tell people unsure about starting to farm? Would you like to see more farmers?
10. Where did you grow up and how many siblings do you have?
11. Who do you live with now?
12. What do you like to do with free time?
13. What are a few significant events in your life?
14. What are some things you are proud of and why?
15. What is one important lesson you have learned?
16. Favorite food?

*10.3.2 Boat Captain*

1. How and why did you become involved in the coral restoration project? Were you previously aware of Marine Cultures?
2. Are you interested in ocean conservation?
3. What were the positives of the Chumbe training? Any negatives?
4. What do friends and family think about coral restoration?

5. Did you have knowledge of coral before the training? What did you learn? Useful skills?
6. Do you think this will be a good source of income for you now and into the future?
7. How much time do you spend on the boat each day?
8. What are your other responsibilities?
9. How do you advertise?
10. Would you like to see more people become involved in the project?

#### 10.4 Appendix 4: Questions for Jambiani Neighbors

1. Do you know about Marine Cultures? How did you hear about it? What do you think about it?
2. Are you interested in learning more about Marine Cultures?
3. Have you seen/visited sponge farms?
4. How many sponge farmers do you know? Have you talked about it with them? Did speaking with them influence your opinion of sponge farming?
5. What is your current occupation/ job? Are you satisfied with your job?
6. What are the main challenges of your current job?
7. Do you know about growing corals? How did you know of it?
8. Are you interested in learning more about it?
9. Are you convinced to sponge farm? If not, what would convince you?

#### 10.5 Appendix 5: List of Participant Observations and Interviews

##### 10.5.1 Participant Observation:

- 11 Nov, 8:30am to 12pm, low tide at 9:30am, depth 1.5m; cleaned algae (*majani*) off sponges and familiarized with farms
- 14 Nov, 10am to 1:45pm, low tide about 11am; did more tending but in addition joined farmers for prep and putting stuff away
- 15 Nov, 10:30am to 1:30pm, low tide around 11:30am; cleaned sponges/ropes, learned how to plant and how to trim
- 16 Nov, 11:15am to 3:45pm low tide 12:12pm; maintenance, took pictures, took part in harvesting/ processing
- 17 Nov, 11:30am to 1:30pm, low tide around 12:50pm; visited other farms and spoke a bit with farmers, took more pictures, rinsed sponges ready for processing
- 25 Nov, 12pm to 2pm at high tide; observed deep water sponge nursery/ reef balls/ coral farm, saw cleaning of tables/ corals/ sponges and took pictures, not really participation so as to adhere to SIT's no diving policy

##### 10.5.2 Formal Interviews (Names were removed for privacy purposes, author has original names)

- 14 Nov, Sponge Farmers 1 and 2 (Aysha), experienced independent farmers, 45 min
- 17 Nov, Sponge Farmer 3, experienced independent farmer, 30 min
- 17 Nov, Sponge Farmer 4, soon to be independent farmer, 30 min
- 19 Nov, Okala Mohammad, age 44, former Marine Cultures project manager of 10 years, JAMABECO NGO, 90 min
- 22 Nov, 5 neighbor interviews, friends/family of farmers, 30 min each
- 24 Nov, Sponge Farmers 5 and 6, relatively new farmers, 1 hr
- 26 Nov, Sponge Farmer 7, relatively new farmer, 40 mins
- 26 Nov, Sponge Farmer 8, relatively new farmer, 40 mins
- 29 Nov, Sponge Farmer 2 (Aysha), 35 mins
- 29 Nov, Sponge Farmer 9 (Fatima), farmer of 3 yrs, 35 mins
- 29 Nov, Sponge Farmer 10 (Latifa), farmer of 3 yrs, 35 mins
- 30 Nov, Coral Farmer 1, 25 mins
- 30 Nov, Coral Farmer 2, 25 mins
- 30 Nov, Coral Farmer 3 (Juma), 25 mins
- 30 Nov, Boat Captain, 25 mins
- 3 Dec, Christian Vaterlaus, Marine Cultures managing director, 80 mins

##### 10.5.3 Informal Interviews

- 11 Nov, Ali Mahmudi, project manager, 3 months in position, in his 20s, conducted while cleaning sponges, mix of English and Kiswahili, communication throughout
- 15 Nov, Ali Pandu, coral farmer and sponge assistant manager of sorts, age 27, conducted in the field, mix of English and Kiswahili, also walked through village
- 25 Nov, brief conversation with Rolf Voorhuis, founder of Reef Care NGO about corals/ partnership with MC

Intermittent brief dialogues occurred throughout the study period with farmers, Marine Cultures staff, and Jambiani residents.

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# Wood-Inhabiting Fungi of the Eastern Ecuadorian Cloud Forest: Fungal diversity comparison along an altitudinal gradient in the Rio Zuñac reserve

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## Abstract

Wood-inhabiting fungi are responsible for the degradation of dead wood, playing a role in nutrient cycling and nutrient transport making them indispensable to their ecosystem's health. Fungi are generally understudied, specifically in the tropics despite its proven hotspot in diversity and the importance of conservation. Wood-inhabiting fungi were investigated in the eastern Andean montane cloud forest of Ecuador to determine the biodiversity, distribution, and relation to an altitudinal gradient. Along multiple ridges of EcoMinga's Rio Zuñac reserve, 13 20x20 meter (0.1-hectare) quadrants between the altitudes of 1300 to 2000 meters were sampled for wood-inhabiting fungi. A total of 175 samples were taken comprised of 36 families and 152 species demonstrating extremely high diversity and low species coverage. Species abundance estimations suggest a much higher quantity of species in the Ecuadorian montane cloud forest than are currently described. Six different altitudes were compared, and it was found that, on a spectrum, communities were neither distinct nor the same provoking the need for more study on the complete effect of altitude and different biotic and abiotic factors.

## Resumen

*Los hongos que habitan en la madera son responsables de la descomposición de los troncos, siendo la base en el ciclo de nutrientes, además son indispensable para el desarrollo del ecosistema. Generalmente los hongos son poco estudiados, especialmente en los trópicos, donde existe una alta biodiversidad de especies y que se debería prestar más atención sobre la importancia y conservación. La investigación sobre los hongos se realizó en el bosque nublado, en una zona comprendida entre la población de Baños y Puyo, al oriente del Ecuador, para biodiversidad, distribución y tendencia existente en esta zona. La muestra se produjo en la reserva del Rio Zuñac, donde la altura del lugar oscila entre los 1300 a 2000 msnm. Dentro de la investigación se determinaron 13 cuadrantes de 20x20 metros (0.1 ha) dentro de ellos se encontraron 152 especies de 36 diferentes familias en 175 muestras colectados. A pesar de haberse encontrado una alta cantidad de especies, esta muestra representa un bajo porcentaje de la cobertura de especies existentes en la zona. En la investigación se tomó en cuenta seis diferentes altitudes para comparar las comunidades de hongos. Se encontró que las comunidades no fueron lo mismo ni distinta.*

**Keywords:** fungal diversity – species coverage – Ecuador – species accumulation – cloud forests

## 1 INTRODUCTION

### 1.1 Background

The kingdom of fungi is one of the most important types of living organisms in the world due to the vital roles to the ecosystem and the influence on human related activities. Fungi are crucial for their tasks in decomposition, nutrient transport, and nutrient cycling making them indispensable to their ecosystem's health<sup>1</sup>. Fungi also have great importance in the economy due to their domestic use in baking, brewing, the pharmaceutical

industry, industrial fermentation, and the millions of dollars lost to building material degradation and food spoilage<sup>2</sup>. Their worldwide impact is representative of their massive breadth of taxa with approximately 100,000 described species<sup>3</sup>. It has been an accepted yet debated hypothesis that there are 1.5 million species of fungus on Earth, but subsequent estimates have ranged from 500,000 to 9.9 million<sup>4</sup>.

The fungal kingdom is comprised of a broad range of sizes, from single celled eukaryotes, in the case of yeast, to the largest and oldest known living organism,



Figure 1. *Gloephyllum* sp1

*Armillaria solidipes*. The largest known *A. solidipes* has been estimated to cover an area of 9.6 km<sup>2</sup> and have an age between 1,900 and 8,650 years old<sup>5</sup>. The study of all types of fungus is a daunting endeavor with difficulties finding mycelium networks and identifying individuals. For that reason, this study will only be examining macrofungi. Macrofungi are defined by having fruiting structures, or fruiting bodies, visible to the naked eye<sup>2</sup>.

Macrofungi are comprised of a few structural components. The most rudimentary component is hyphae, thread-like strands that form an interconnected network known as mycelium<sup>6</sup>. Mycelium is the vegetative system of the fungus, responsible for growth and the absorption of nutrients from the environment. Nutrient absorption occurs in two steps. First, hyphae secrete enzymes which break down macromolecules or polymers into monomers. Second, the broken-down nutrients are absorbed into the mycelium by active transport and facilitated diffusion, providing the energy to expand and reproduce<sup>6</sup>. Reproduction of macrofungi is performed by the fruiting body, a spore producing mass of mycelium. Fruiting bodies, commonly called mushrooms, are the classical way to identify fungi according to their characteristics such as gills, pores, teeth, volva, and annulus. Fruiting bodies release spores, the reproductive entity that are commonly dispersed by wind but also by explicit fauna<sup>7</sup>. The fruiting body and spore characteristics described will be used to identify the fungi in this study. When dispersed, spores can land on a variety of substrata including soil, leaf litter, dead wood, and live trees. The spore will successfully germinate if ecological conditions are favorable, and the species has the biological processes necessary to grow on the substratum.

This study focuses specifically on the substratum of wood and their corresponding macro-wood-inhabiting fungi. Certain wood-inhabiting fungi grow discriminately on different host species, level of decay, and ecological position of substrata<sup>2</sup>. These fungi have the ability to grow and decompose wood due to their enzymes



Figure 2. *Macromytilidia* sp1.

that break down lignin, the compound that physically protects cellulose<sup>7</sup>. Thus, they are known as lignicolous fungi. The process of wood decomposition involves several groups of organisms: bacteria, nematodes, protozoa, arthropods, and insects but under normal conditions fungi are the primary agents<sup>8</sup>.

Dead wood has proven to be an essential component of forest ecosystems due to its contributions to organic soil matter, reduction of erosion, and service as a reserve for nutrients and water<sup>9</sup>. The input of dead wood to mature forest ecosystems represents 30-40% of total biomass and it is the job of the wood-inhabiting fungi to recycle this mass<sup>10</sup>. There have been numerous studies studying the relationship between wood decay in temperate forests but there is a gap in knowledge around non-pathogenic tropical wood-inhabiting fungi. There is strong conservational need for this information due to the global decomposition of wood releasing CO<sub>2</sub> at 6-9.5 Pg C/year, comparable to fossil-fuel combustion at 9.5 Pg C/year<sup>11</sup>. Therefore, diversity of wood-inhabiting fungi controlling decomposition could hold broad importance to carbon cycle-climate feedback and implications of climate change<sup>11</sup>.

Poroid and corticoid wood-inhabiting fungi are macrofungi that have been recognized as a valuable reference point for biodiversity, conservation value, and wood decomposition, likely due to their visibility<sup>12</sup>. Unlike temperate zones, little is known surrounding the factors affecting polypore diversity and distribution in the neotropics, hence the conservation of these organisms is difficult<sup>13</sup>.

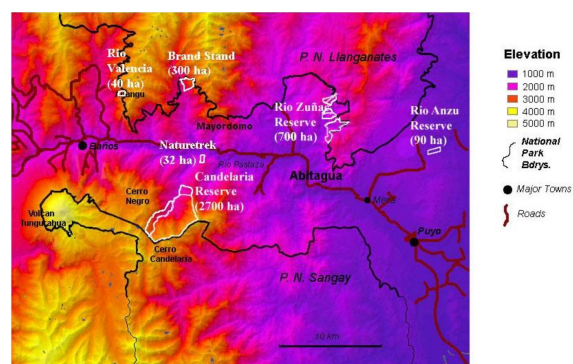
No individual, species, or population lives in ecological isolation without interactions with the biotic and abiotic components of their complex ecosystem, and fungi is no exception<sup>14</sup>. Consequently, the ecological structure of their communities must be studied to detect patterns in fungal diversity. These include host species diversity, precipitation, latitude, soil composition, elevation, and the presence of human activities<sup>15</sup>. This investigation will focus on patterns along an elevation gradient while taking into account the effects of human

## Wood-Inhabiting Fungi

disturbance on the geographic location.

## 1.2 Location

This study was conducted in the Rio Zuñac reserve, located inside the Rio Pastaza watershed in the eastern Andean cloud forest of Ecuador. The private reserve belongs to the EcoMinga Foundation, an organization that protects the valley lying between Parque Nacional Sangay and Llanganates. The Rio Zuñac reserve is located on the Andes ridge closest to the Ecuadorian Amazon. The Eastern Andes of Ecuador, specifically at the latitude that the reserve lies, are comprised of montane cloud forests with an elevation range of 1300 to 3000 meters above sea level<sup>16</sup>.



**Figure 3.** Elevation map of the upper Rio Pastaza watershed with six of the ten EcoMinga reserves indicated<sup>17</sup>

The eastern Andes mountain range in Ecuador acts as a barrier to the trade winds that converge on the equator moving west to east. When the prevailing winds meet the eastern Andes, the water vapor condenses to form clouds resulting in consistently high humidity and precipitation<sup>18</sup>. The elevational and precipitation gradients in this valley apply varying abiotic factors, influencing niches and biotic diversity. These unique montane cloud forests are filled with lichens, climbing ferns, epiphytes, mosses, and orchids that form thick layers around trees creating microclimates<sup>19</sup>. This valley has a greater number of endemic botanical species than the Galapagos Archipelago in a smaller area<sup>16</sup>.

This complex ecosystem and geographic location provide optimal conditions for high fungal diversity. A study hoping to disentangle the roles of climatic, edaphic, floristic, and spatial parameters on fungal diversity on a global scale found that distance from the equator and mean annual precipitation had the strongest effects on richness while fungal diversity and endemism peaked in tropical ecosystems<sup>20</sup>. Additionally, a study in the eastern Andean montane cloud forest in Argentina found that an elevation gradient differentially affected distribution and species richness of four orders of Agaricomycetes<sup>3</sup>. Despite, Ecuador capturing

practically all the proven parameters of high fungal diversity there are only 845 documented species while China contains approximately 27,900 species in the *Checklist of Fungi in China* database<sup>21</sup>. That being said, there is a massive need for mycological investigations in this unique area of Ecuador to start to unravel the distribution and diversity of fungi for the purpose of conservation and the understanding of the ecosystem as a whole.

## 1.3 Objectives & Hypotheses

The main objective of this study is to sample and determine the richness and diversity of the fungi that inhabit the wood in the Zuñac river reserve. The altitudinal gradient was studied, the communities at each elevation were compared according to the abundance of families and species. The similarities or differences in the communities provided information on the fungal distribution of macro fungi based on the altitude gradient.

This information forms the basis for a better understanding of the distribution of the fungi that inhabit the wood in a montane cloud forest, the results of which will contribute to the knowledge of wood fungi for future studies and the conservation of the reserve. The results of this abiotic gradient compared to future studies of abiotic factors, such as precipitation, will provide a more complete picture of the diversity and ecology of fungi in tropical montane forests.

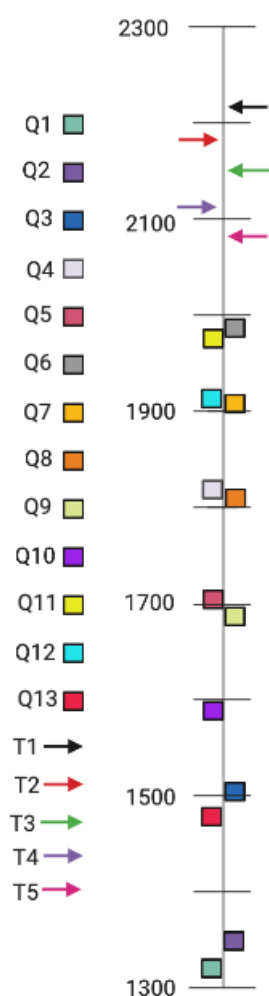
## 2 METHODS

Classic methods were used to study wood macro-fungi specifically classical substrate-based methods, the study was conducted between November 11<sup>th</sup> and 28<sup>th</sup>, 2019. The classic methods consist of taking samples while recording the characteristics of the fruit body and the substrate and then proceed to taxonomic identification. Regardless of the recent popularity and advancements in molecular methods, classical methods have advantages in the inventory of fungi in a clearly defined area or substrate as well as the creation of a species list<sup>22</sup>. Species list can then be used for conservation or comparing communities across regions. Consistent with classical methods, a plot-based study was combined with opportunistic sampling with the purpose of representing the fungi region as a whole and identification of communities.

### 2.1 Plot-based Study

For the fungus collection, 13 quadrants of 20x20m were established until reaching 0.1-hectares, to effectively cover the entire established area in a reasonable period of time, the methodology was completed with 5 transects of 20-meter near the quadrants. All four sides of

the quadrant were measured with a field measuring tape and cut as limits for the search for macro fungi. The elevation and coordinates of the four corners of each quadrant were recorded using the "My Altitude Application". Each of the fallen, sloping, and vertical dead trees were specifically screened for fungi, without ignoring the live trees. The first two quadrants were reviewed for three hours, therefore, all the remaining quadrants were examined at the same time to apply the same search effort. Clarifying, that the time to describe, measure and take photos of each sample was often the longest to the established time. Therefore, the quadrants with more samples had less search effort.



**Figure 4.** The distribution of quadrants and transects according to meters above sea level.

With the purpose of the study being to identify changes in fungal community according to altitude, locations for the quadrants were placed about every 100 meters of elevation, always near the trail. Two quadrants were performed for each 100 meters of elevation

besides 1400, 1600, and above 2000m. The fluctuations to every 100 meters and duplicate quadrants were due to the high variability of the region. Some stretches, specifically the altitudes below 1700 meters, were recently disturbed in the interest of accessibility for cattle and agriculture, therefore dense in low vegetation. On the other hand, high altitudes were extremely steep making it impossible to navigate uniformly in search of fungi. Thus, the primary forest search consisted of 8 quadrants between 1700-2000m. The secondary forest search consisted of 4 quadrants from 1300-1500m. To effectively represent the extent of the region five transects were performed between 2092-2210m following the same methods without the physical quadrant for equal sample effort.

Sampling was done with the purpose of fungal identification. When a fruiting body was encountered inside the quadrants, first photos of the top and underside were taken. This provided an unaltered representation of the fungi before any possible damage occurred when the sample was removed from the substrate. The sample was given a sample number according to the quadrant and a brief description based upon fruiting body characteristics. The substratum was then observed. The wood was classified as alive or dead, whether it was on the trunk or branches, the bark intactness, level of decomposition, the diameter, and whether it was lying on the ground, upright, or suspended. The sample was then taken by cutting the fruiting body from the substratum with a pocketknife. The sample was then carefully wrapped in wax paper, keeping the characteristics intact, and then placed in a labeled paper bag. All samples were placed in a hard sample box for protection and organization.



**Figure 5.** *Oxyporus sp1.*

The samples were taken back to the station where they were organized, and the characteristics were described in detail. All of the fresh fruiting bodies were photographed with a white or black background and a penny for scale, as seen in Figure 5. For the wood-inhabiting fungi that had a cap or visible spores present, a spore print was attempted. The stalks of the capped mushrooms were cut off and placed equally on white

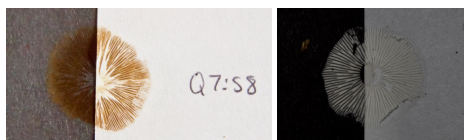
## Wood-Inhabiting Fungi

**Table 1** Example sample taken. The sample number indicates that it is the third individual from Quadrant 8 (located from 1800-1815m). Later identified as *Oxyporus* sp1. Figure 5

<b>Sample Number</b>	Q8, S3
<b>Description</b>	Cantaloupe orange radiating disk polypore with spinach green stains on top face
<b>Substrata</b>	Dead tree
<b>Position</b>	Suspended
<b>Bark Intactness</b>	3
<b>Level of Decomposition</b>	1
<b>Diameter (cm)</b>	17.2
<b>Growth Habit</b>	Gregarious
<b>Spore Dispersal</b>	Porous

and black construction paper, as seen in Figure 6. The samples were left for 24 hours and then unveiled. The color of the spores was noted. The handheld microscope was also used to examine spores and describe the shape when possible.

Due to the lack of materials and success in previous studies, it was not attempted to dry the fungi by stovetop or other mechanical methods in the field<sup>23</sup>. The larger fruiting bodies were placed in the sun to dry, if the weather allowed, and were then moved in the research station where open windows allowed for wind drying. The dry fungi were then placed in labeled envelopes and stored to take back to Quito.



**Figure 6.** Examples of successful spore prints.

After the 3-week collection period, the samples were taken to Quito in their paper envelopes and deposited in the National Herbarium of Ecuador, part of the National Institute of Biodiversity. Some samples were adequately dehydrated in a fungus dryer, it can be seen in the description (Table 1) and some characteristics taken in the field phase, were used for identification. Some fungi were identified to the species while others only to the family, therefore a morphospecies name were given to these samples. The dried samples were documented and donated to the Herbario Nacional de Ecuador.

To analyze the diversity of all the samples, diversity indices of Chao1, Chao1-bc, ACE-1, transformed Shannon entropy, and transformed Gini-Simpson were calculated for both the species and families. Each of these diversity indices compares the degree of similarity in species or family between two communities, in this case different altitudes. The species diversity by number of individuals, species coverage, and sample coverage

were presented for the species and families for a study as a whole. To compare the different altitudinal communities, each were given equal weight due to equal sample effort and similarity indices were calculated for each diversity order to ensure comparison from a rare and common point of view. For a diversity order of 0 the Sorensen overlap and Jaccard shared diversity were calculated. For a diversity order of 1 Shannon beta diversity and horn overlap were analyzed. Finally, for a diversity order of 2, Morisita-Horn overlap was used.

### 3 RESULTS

#### 3.1 Sample Diversity

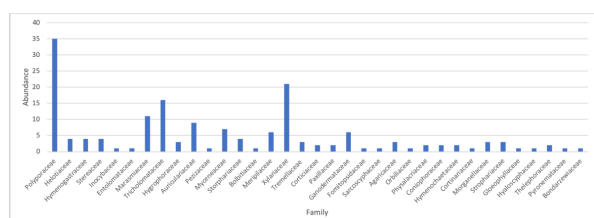
In the structured collection time of the 13 0.1-hectare plots, 152 samples were documented. In addition to the quadrants, 23 opportunistic samples were taken from trail sides, or plots from the sister study investigating terrestrial fungi, producing a total abundance of 175. 40 of the samples were identified to species, 117 were given morphospecies to the genus, and 18 were given morphospecies to the family.

The Chao1 biodiversity index is a species richness estimator which uses the number of singletons (F1) and doubletons (F2), due to missing species information being concentrated in the low frequency accounts<sup>24</sup>. The coefficient of variation (CV) measures the heterogeneity of a sample, the higher the more heterogeneous<sup>25</sup>. A CV of 1.059 and 1.46 shows that the detection probability was not equal for all species, indicating a highly heterogeneous community. For this reason, the Chao1 was treated as the estimation's lower bound rather than the corrected Chao1-bc which is more accurate for a homogenous community. The modified Abundance-based Coverage (ACE-1) estimator uses the information contained at higher frequencies ( $f_3$ - $f_{cutt\ off}$ ) and was treated as the point estimate due to its sensitivity to heterogeneous communities<sup>26</sup>. The lower bound (Chao1) was used to calculate the undetected number of species and

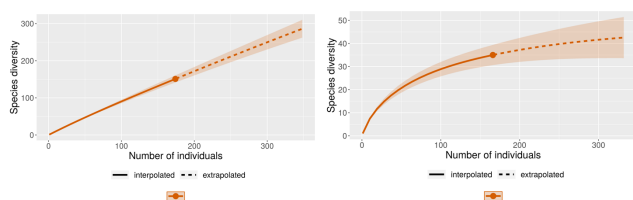
**Table 2** Biodiversity indices of all plots, altitudes, and opportunistic samples according to species and families

	Species	Family
<b>Richness</b>	152	36
<b>Abundance</b>	175	175
<b>Singletons (F1)</b>	141	12
<b>Doubletons (F2)</b>	5	6
<b>Chao1</b>	1800.39	50.00
<b>ACE-1</b>	3059	52.41
<b>CV</b>	1.06	1.46
<b>Undetected #</b>	1648	14.00
<b>Undetected %</b>	90.78	28.00

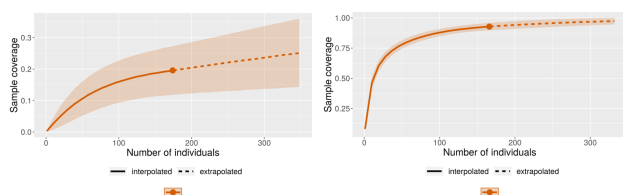
families ( $Chao1 - Richness = Undetected\ number$ ).



**Figure 7.** The abundances of each family present of all samples.



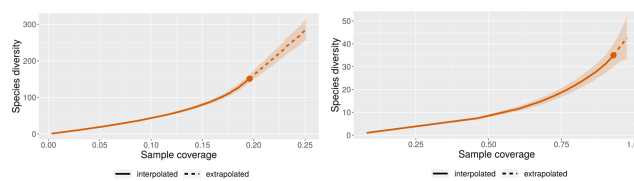
**Figure 8.** The sample-sized based rarefaction and extrapolation diversity curve of the species (left) and families (right) of all samples.



**Figure 9.** The sample-coverage based rarefaction and extrapolation sample coverage curve of the species (left) and families (right) of all samples.

### 3.2 Comparing Altitudes

The observed families were used explicitly to compare communities based upon altitude, because of the large number of species singletons throughout sampling. If species were used for comparison, all the communities, including quadrants of the same altitude, would be considered distinct. The samples from the six altitudes



**Figure 10.** The coverage-based rarefaction and extrapolation diversity curve of species (left) and families (right) of all samples.

with two quadrants each were combined and used as communities for comparison. Shown in Table 2., the sample size of each altitude ranges from 16 to 31 while the number of observed families ranges from 10 to 13. Despite the variation in sample size throughout the altitudes, the number of observed families is consistent, and the sample effort was equal for each.

For the community comparison indices, the communities were all weighted equally. It is suggested that if the species, or family, frequencies, not the actual sizes of communities are the topic of interest, as in this case, equal weights should be used<sup>27</sup>. To compare strictly family richness, with a diversity order ( $q$ ) of 0, the Sorensen overlap and Jaccard shared diversity indices were used. These indices, as well as the Horn overlap ( $q=1$ ) and Morisita-Horn ( $q=2$ ) measure on a range of 0 to 1, 0 being identical and 1 being completely distinct. The Shannon Beta diversity exhibits how many distinct communities there are. The 1500/1700m comparison had the highest beta diversity, the most distinct, while the 1300/1500m comparison had the lowest beta diversity, the most similar.

## 4 DISCUSSION

### 4.1 Plot-based Study

The overall sampling of the study including all altitudes found an extremely diverse fungal community. Due to the extremely high number of singletons encountered, 141 of 152 samples, the Chao1 estimated a species richness of 1800.39. Therefore, the sampling encountered

**Table 3** The sample size and the number of observed families for the two 0.1-hectare quadrants at each altitude.

	Sample Size	Number of Observed Families	Transformed Shannon Entropy	Transformed Gini-Simpson
1300 m	21	10	7.388	5.580
1500 m	31	13	10.833	9.330
1700 m	16	10	8.443	7.111
1800 m	21	13	11.029	9.383
1900 m	22	11	9.105	7.806
2000 m	19	12	10.790	9.757

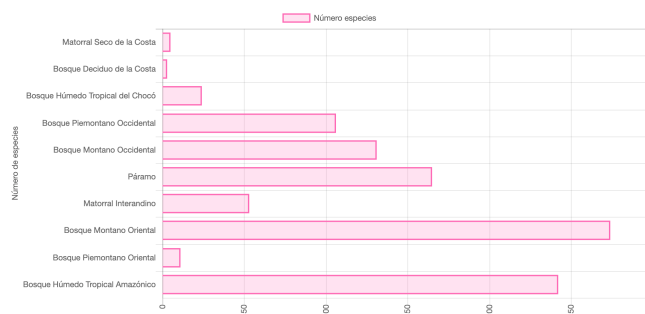
**Table 4** Biodiversity indices to compare two altitudinal communities.

	$C_{02}$ , Sorensen Overlap ( $q=0$ )	$U_{02}$ , Jaccard Shared Diversity ( $q=0$ )	Shannon Beta Diversity ( $q=1$ )	$C_{12} = U_{12}$ , Horn Overlap ( $q=1$ )	$C_{22}$ , Morisita- Horn Overlap
1300 / 1500 m	0.5217	0.3529	1.282	0.6411	0.6438
1500 / 1700 m	0.5217	0.3529	1.5208	0.6771	0.7811
1700 / 1800 m	0.3478	0.2105	1.4034	0.5111	0.6742
1800 / 1900 m	0.5000	0.3333	1.4021	0.5124	0.4981
1900 / 2000 m	0.4348	0.2778	1.3968	0.5179	0.5602
1300 / 2000 m	0.4545	0.2941	1.4249	0.4891	0.4272

9.22% of the projected species in the community, based upon the lower bound. If the species richness point estimate was used (ACE-1), the study encountered only 4.97% of the species. Although the quantity of species encountered appears to only represent a small percentage of the community, this confirms the thinking in literature surrounding the extremely high fungal diversity in the tropics and specifically in the montane cloud forest<sup>3</sup>. Due to the high number of singletons when analyzing species richness and abundance, the diversity of fungal families was also investigated in order to draw further conclusions about the identity of the community.

A total family richness of 36 was found. The lower bound richness estimate was 50 with a point estimate of 52.41 indicating the study encountered 72% of the families present. This demonstrates that the study did effectively cover the sample region in regard to families. If the lower bound estimate of 50 families is correct, this expresses extremely high fungal diversity. The majority of the families had a low abundance of five individuals or less but *Polyporaceae*, *Xylariaceae*, and *Tricholomataceae* showed the highest abundance. The two most abundant, *Polyporaceae* and *Xylariaceae* are known for being common lignicolous, wood-inhabiting fungi in the tropics, consistent with the findings of this study<sup>21</sup>. Furthermore, *Xylariaceae* is the most diverse family in Ecuador with 120 species<sup>28</sup>. Currently, there are 73 families of fungi on Earth and in a 1.3-hectare total sample area plus opportunistic sampling 49.32% were encountered and an estimated 68.49% were present. Even for

the tropics, this is high biodiversity. Compared to other regions of Ecuador, it has been shown that the eastern montane cloud forest has the highest fungal species diversity<sup>21</sup>.

**Figure 11.** A comparison of species richness to the different regions of Ecuador, from the FungiWebEcuador (Ordoñez, 2018).

First, analyzing the richness and abundance of species, at the species diversity versus the number of individuals it is clear that the study was far from reaching an asymptote noted by the straight line with a small error range on the left graph of Figure 8. This lack of a diversity plateau is consistent with investigations of a longer period of time such as a study focusing on the diversity of wood-inhabiting fungi along a rainfall gradient in Costa Rica<sup>9</sup>. This study lasted one year and concluded that the species ensemble was not completely sampled for any of their sample sites along the rainfall gradient<sup>9</sup>. Comparing this three-week study to that of one year exposes the time and resources necessary

to effectively sample a fungal population. The sample coverage graph (Figure 9) for species demonstrates a sample coverage of 19.73% with large error and small slope of extrapolation. This early plateau indicates high biodiversity and a much higher number of individuals would be necessary to have a complete sample coverage. The sample coverage-based diversity curve (Figure 10) shows that with only a sample coverage of 19.73% the species diversity is increasing rapidly and can be assumed that with a higher sample coverage the diversity will reach an asymptote and indicate extreme diversity.

Second, analyzing the richness and abundance of families, the diversity curve (Figure 8) shows the beginning of an asymptote. This implies that family diversity was well represented in this study and by doubling the sample size the family richness would only be extrapolated to approximately 41 families, a small increase compared to the species. The sample coverage curve (Figure 8) indicates a very high sample coverage and a clear asymptote. Lastly, the coverage-based diversity curve (Figure 10) accurately describes the diversity with the high sample coverage, needing only slight extrapolation. Overall, the fungi families were effectively sampled in this study justified by the high sample coverage and plateau of the family diversity. Compared to the families, the species were less effectively sampled due to the immense diversity present.

#### 4.2 Comparing Altitudes

Each of the six altitudes, which received equal sample effort, had a similar number of observed families with varying abundances. The only two families that were present in all six altitudes, consistent with the most common families overall, were *Polyporaceae* and *Xylariaceae* with varying abundance. For example, at 1300m there were seven individuals of *Polyporaceae* while at 2000m there was one. This difference in abundance was quantitatively shown in the comparison of 1300/2000m with a lower value of 0.4272 for the Morisita-Horn overlap ( $q=2$ ), which puts emphasis on common families. On the other hand, the comparison of 1500/1700m had a high Morisita-Horn overlap of 0.7811 due to the similarity in relative abundance of these two families. The presence of these families at each altitude basically indicates the adaptability of these families to the different humidity, precipitation, and forest structure associated with the altitudes.

None of the six community comparisons using similarity and overlap indices show quantitatively close to identical communities while neither do they show close to completely distinct communities. The communities that were the most distinct were 1500/1700m. They had the highest Shannon beta diversity of 1.5208, the highest Horn overlap ( $q=1$ ) and Morisita-Horn overlap, combined with the largest difference in sample size and

observed number of families. That being said, the difference in these communities is definitely affected by the altitudinal difference, but other factors are involved. The 1500m quadrants were in secondary forest with more low vegetation while the 1700m quadrants were located in mature primary forest with larger trees and less ground cover. In a study comparing distribution of poroid fungi to different forest types found that the different forest types did not form distinct communities, but the areas did have different fungi best explained by the distance between the areas<sup>13</sup>. In this study, and that which compared forest types, the singular gradient focused on could not definitively separate the fungal communities on their own.

Due to the complexity of fungal communities, experts are still trying to formulate effective ways to represent distinctions in communities by gradients and abiotic factors. To effectively understand the communities many factors should be studied together. The problem with this is determining what factor is responsible for differences. For this reason, this study did not undertake both level of human disturbance and altitude, rather only considered the effect of altitude. An example of studying two factors is an investigation in Costa Rica looking at the effect of altitudinal and humidity gradients<sup>29</sup>. Their main finding was the differences in the polypore communities according to levels of humidity. They also found significant difference according to altitude but the main difference in polypore fauna occurred at the same altitude<sup>29</sup>. This conflicting community difference shows the difficulty of observing two gradients, or specifically altitude. Likewise, a study on the distribution of polypores in the Brazilian Amazonia found very little similarity among transects in the same primary forest<sup>30</sup>.

These examples show the difficulty in formulating conclusions in fungal diversity according to traditional gradient measures. The most successful example of this is an investigation looking at species composition of Agaricomycetes according to a vegetational and elevational gradient<sup>3</sup>. The success of this study was mostly responsible to their defined sample areas. Three completely different altitudes with three completely different types of forest. They found the elevational gradient to have a strong influence on the fungal community, most likely due to the forest types changing the host plants, soil composition, and distribution of substratum<sup>3</sup>. This shows that a comprehensive approach is necessary when considering the effect of altitude on fungal communities.

#### 5 CONCLUSION

This study successfully provided EcoMinga's Rio Zuñac reserve located in the eastern Ecuadorian montane cloud forest with a morphospecies list of 152 species of

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wood-inhabiting fungi through the use of 0.1-hectare plots and opportunistic sampling. This region was found to be incredibly diverse in fungal species with an estimated number of 1800.39 species despite their only being 845 documented species in all of Ecuador<sup>21</sup>. When the diversity was compared on an altitudinal gradient it was neither quantitatively confirmed nor disproven that each 100 meters of elevation was comprised of a distinct fungal community. This study, combined with previous gradient fungal studies, brings about the question of the validity of current fungal study methods. Study of fungal communities is ecologically complicated and therefore requires more consideration to the many abiotic and biotic factors involved. The implications of the wood-inhabiting fungi in the tropics holds large importance in a comprehensive view of forest ecosystems and the carbon feedback cycle that affects climate. Future tropical fungal studies should look at multiple biotic and abiotic factors, such as prevalence and identity of substratum, precipitation, humidity, disturbance level, and botanical identity over a longer sampling period.

## 6 ACKNOWLEDGEMENTS

This investigation would not have been possible without the help and guidance of many people. I would first like to thank the park guards, Santiago and Fausto (Tito), who wielded machetes through the thicket without a missed step and kept moral up with delicious meals after long, wet days. Secondly, the biggest thanks to Estalina for calling me “Paquito” and a “Sapo” every day. A woman who is just wonderful in all senses of the word. Much gratitude to my project advisor Rosita Batallas for bearing through the long hours of identification and fungi guidance. I am extremely grateful for my academic director Xavier Silva and assistant academic director Ana Maria Ortega for their continuous support and advice throughout the program. Finally, thanks to all the staff at the Experiment of International Living (EIL) and SIT: Ecuador, specifically Diana Serrano for endless support and creating an experience of a lifetime.

## 7 EDITOR'S NOTES

This article was peer reviewed.

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# Examining the Roles of the Conserved mRNA Deadenylation Complex on *Drosophila* Neuronal Structures

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## Abstract

The most common cause of inherited mental deficiency and monogenetic cause of autism is Fragile X Syndrome (FXS). There is little known about the origins of this disease which will be investigated in the present study. The series of experiments conducted examined the potential role of mRNA deadenylation proteins as contributing factors to the pathogenesis of FXS using *Drosophila melanogaster* as a model organism. One of the main complexes involved in deadenylation is the CNOT complex, which is comprised of many proteins, including POP2, TWIN, and NOT3. Each protein plays a unique role within the CNOT complex. This goal of this study was to further characterize these genes. Previous research in the Barbee lab has shown that these genes influence synapse development of the pre-synaptic terminal at the larval neuromuscular junction in *D. melanogaster*. However, it had not been tested whether POP2, TWIN, and NOT3 also have a post-synaptic effect. The localization of these genes at the neuromuscular junction was also examined and they were found to be concentrated in the pre-synaptic terminal. Finally, this study looked at whether these genes had any role in the development of sensory neurons. There was a significant increase in sensory neuron dendritic growth and a significant decrease in the complexity of the dendritic branches. These results provide insight into the characterization of TWIN, POP2, and NOT3, and their roles within the development of *D. melanogaster*. Future experiments will examine the genetic and biochemical relationship between the deadenylation complex and FXS in the *D. melanogaster* model.

**Keywords:** Fragile X Syndrome, NOT3, POP2, TWIN, neuromuscular junction, deadenylation, *Drosophila*, synaptic development

## 1 INTRODUCTION

In the current human population, it is estimated that about 1.4 per 10,000 males and 0.9 per 10,000 females suffer from Fragile X Syndrome (FXS)<sup>1</sup>. This neurodevelopmental disease is the most common form of inherited mental deficiency in humans and is one of the best characterized monogenetic causes of autism. FXS has been attributed to causing developmental delays in children, as well as hyperactivity, anxiety, attention deficits, and difficulty reaching early language milestones<sup>2</sup>. A common method used to study this sort of disease is by using *Drosophila melanogaster* (the common fruit fly) as a genetic model organism. *D. melanogaster* offers the benefit of a relatively short regeneration time, a fully sequenced genome, and easy upkeep in a laboratory setting<sup>3</sup>.

In humans, glutamate is the primary neurotransmitter used to conduct signaling across the synaptic cleft in the brain. Similarly, in fruit flies, glutamate is the pri-

mary neurotransmitter used within the muscles, making the neuromuscular junction (NMJ) a good model for the conserved signaling pathways in humans. Another reason why *Drosophila* neurons are ideal models for mammalian neurons is due to their shared use of Fragile X mental retardation protein (FMRP) in controlling synapse development from the presynaptic side. This has been well-established and contributes to evidence suggesting that their functions may be related in both humans and *Drosophila*<sup>4</sup>. The strong similarity between these areas provides the foundation for using the *D. melanogaster* NMJ as a model of the human brain. The identification of the proteins and mechanisms involved in its pathogenesis presents significant potential for future research and the development of a treatment.

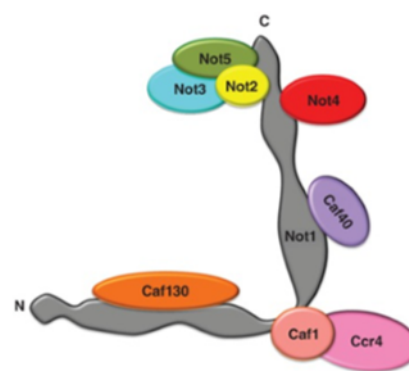
Of the potential causes behind FXS, FMRP has been well-characterized as a critical protein in the development of the brain and in synaptic regulation<sup>4</sup>. FMRP is an important neuronal protein required for the repression of specific mRNA translation, although its

exact mechanism and the genes it represses are still unknown<sup>4</sup>. The gene which codes for FMRP, Fragile X mental retardation 1 (Fmr1), is epigenetically silenced in FXS, thereby causing intellectual disability<sup>4</sup>. Originally, a CCG trinucleotide expansion in the 5' non-coding region of Fmr1 was found in organisms exhibiting FXS, mostly located in the promoter region of the gene<sup>2;5</sup>. Therefore, previous studies have concluded that the molecular cause of FXS arises from a loss-of-function mutation in Fmr1<sup>4</sup>. There is a plethora of genes which help FMRP bind to mRNAs and regulate their translation. Prior research within the Barbee lab has identified genes that share a similar loss-of-function phenotype and may interact with and regulate the function of FMRP<sup>6</sup>. Preliminary data suggests that FMRP may bind to important mRNAs and regulate their translation by targeting them for deadenylation and 5' to 3' mRNA decay.

These mRNA molecules are critical to the functioning and survival of the cell. mRNA acts as an intermediate between DNA and ribosomes by working to convey genetic information between the two. In the ribosome, mRNA is translated into proteins which are integral to cell functioning and survival. It is highly regulated both individually and through mRNA processing and other protein interactions, such as with RNA-binding proteins. A key component of mRNAs is the addition of a poly-A tail<sup>7</sup>. The addition of a poly-A tail both promotes efficient translation and protects the molecule against non-specific degradation in the cytoplasm<sup>8</sup>. After that, poly(A)-binding protein nuclear I (PABNI) is attached to the string of adenosine molecules. PABNI acts to prevent degradation and preserve the length of the poly-A tail<sup>9</sup>. When a strand of mRNA is no longer needed, it is targeted for degradation. One of the first steps to its breakdown is to remove the poly-A tail (this process is known as deadenylation). Of the genes previously characterized as part of the functioning of FMRP, TWIN (also known as CCR4), POP2 (also known as CAF1), and NOT3 are of particular interest due to their role in the process of deadenylation of mRNA<sup>6</sup>. These three genes take part in the blueprint for the complex needed to perform deadenylation. Without them, mRNA potentially won't be degraded, leading to difficulties in overall cell function.

There are two complexes that work together to deadenylate cytoplasmic mRNA during degradation. The PAN2-PAN3 complex works first to shorten the poly-A tail to 110nt and is followed by a second complex, CNOT, which degrades the remaining portion of the poly-A tail<sup>10</sup>. It has been found that the 3' untranslated region (UTR) activates the CCR4-NOT complex via bound proteins, either directly or indirectly<sup>11</sup>. The process of deadenylation is microRNA (miRNA) mediated. Within non-coding RNAs, miRNAs are believed to control translation of specific mRNAs by complement-

ing with antisense sequences in the 3' UTR of these messages, thereby repressing gene transcription<sup>12</sup>. Within the CNOT complex, the NOT1 gene acts as the scaffold to which all other genes bind, including CAF1, CCR4, and NOT3. It has been hypothesized that the NOT3 and CAF1 complexes work to degrade the initial portion of the poly-A tail, while the CCR4 complex plays an important role in interacting with polyadenylate-binding protein 1 (PABP1) to be able to remove the last of the poly-A tail. Although there has been evidence that CNOT may have the capability to remove the entire poly-A tail, it has not been well studied up to this point<sup>13</sup>. Within a previous genetic screen in the Barbee



**Figure 1.** Sample image of the CCR4-NOT complex. Caf1 and Not3 are shown to directly interact with the Not1 scaffolding protein. Ccr4 is attached to the complex via its interaction with Caf1.

lab, results concluded that the pre-synaptic knockdown of NOT3, CCR4, and CAF1 all caused a significant increase in synaptic growth at the NMJ and are therefore important for regulating its development<sup>6</sup>. Synaptic growth has been previously measured by the number of boutons present at the synapse. Boutons are small swellings found at the terminal ends of axons and have been shown to be highly plastic in development. Although there are different classifications of boutons, I focused on counting type 1 boutons which are glutamatergic and can be either large or small<sup>14</sup>.

This study includes four different experiments which will address the different functionalities of NOT3, TWIN, and POP2 throughout various neurons of *D. melanogaster*. I first elucidated the pre-synaptic and post-synaptic effects of NOT3, POP2, and TWIN at the NMJ. There was a significant increase in number of synaptic boutons with both the pre-synaptic and post-synaptic knockdown of each of these genes. I next established the localization of TWIN and NOT3 at the NMJ. This experiment revealed that these genes localize in the pre-synaptic terminal but not in the post-synaptic terminal. Finally, this study determined the effects of POP2, TWIN, and NOT3 on sensory neuron dendrite morphogenesis. There was a demonstrated increase in dendritic

*Conserved mRNA Deadenylation*

size with the knockdown of NOT3 and a demonstrated decrease in complexity with the knockdown of POP2. These results provide the foundation for future studies. It is with these results that I hope to further determine the role that TWIN, POP2, and NOT3 play in the function of FMRP, and ultimately in the molecular pathogenesis of FXS.

## 2 METHODS

### 2.1 *D. melanogaster* stocks

All fly lines and crosses were maintained at 25°C on standard Bloomington media. All strains used for each experiment were obtained from C380-Gal4, *sco/cyo*;24BGal4/Tm6b, BL CantonS, *ppkGal4*; UAS *cd4:tdTOMATO/cyo*, and UAS-TRiP LucIII, UAS-TRiP NOT3, UAS-TRiP/*cyo* POP2, UAS-TRiP TWIN.

### 2.2 Neuromuscular Junction Dissections

Larval body wall preps for NMJ and muscle analysis were performed on wandering third-instar larvae in JanJan buffer. Unless otherwise indicated, preps were stained as previously described<sup>6</sup>. The preps were fixed using a 4% paraformaldehyde solution followed by washes in 1X-phosphate buffered saline (1x-PBS) and overnight incubation in primary antibodies diluted with block. The following day, the preps washed with Triton X-100 (PBS-T) and incubated with secondary antibodies diluted in block for 1 hour. All preps were mounted in DAPI Fluoromount-G (Southern Biotech) and stored at -20°C until imaged via confocal microscopy.

### 2.3 Imaging

All imaging was performed on an Olympus Fluoview FV3000 scanning confocal microscope with 40X or 60X objectives (N.A. 1.30 and 1.42, respectively). A maximum Z projection for each synapse was assembled from 0.4 mm optical sections using the Olympus FV software. For all analysis, images were manually adjusted to threshold.

### 2.4 Pre-synaptic knockdown assay

To test whether a pre-synaptic knockdown of NOT3, POP2, and TWIN had any effect on the development of the synapse at the neuromuscular junction, 10-15 virgin females from C380-Gal4 line were crossed with 5 males from each UAS-TRiP line. The resulting wandering third-instar larvae from this cross were dissected using the protocol outlined above with the primary antibody anti-discs large (DLG) at a 3:300 dilution and the secondary antibodies anti-HRP-A647 and goat anti-

mouse A488, both at 1:500 dilutions. The muscles of their A3 segments were imaged using the protocol outlined above on a scanning confocal microscope. Images were randomized blindly and the total number of boutons at the synapse were manually counted and recorded for each image using the Cell Counting plugin for Image J v1.45. All image processing was done in ImageJ and Adobe Photoshop.

Statistical testing was performed in Graphpad Prism. A one-way ANOVA followed by Dunnett's multiple comparisons test was used to determine if there was any significance between the total number of boutons for each knockdown. A Brown-Forsythe test and a Bartlett's test were performed to ensure there was no significant variance between the samples.

### 2.5 Post-synaptic knockdown assay

To test whether a post-synaptic knockdown of NOT3, POP2, and TWIN had any effect on the development of the synapse at the neuromuscular junction, 10-15 virgin females from the muscle driver line *sco/cyo*;24BGal4/Tm6b were crossed with 5 adult males from each UAS-TRiP line. The same protocol as the pre-synaptic experiment was used for dissections, staining, and imaging with the same fluorescent antibodies.

Due to statistically significant variance being present between the samples, a Kruskal-Wallis test followed by a Dunn's multiple comparisons test was performed in Graphpad Prism on the resulting bouton counts.

### 2.6 Colocalization assay

To address the third aim of this paper, NMJ dissections were performed on wandering third-instar larvae from the control line, CantonS, according to the procedures outlined above. The primary antibodies used were rabbit anti-CCR4 in a 1:400 dilution and mouse anti-NOT1 in a 1:1000 dilution. The secondary antibodies used were anti-HRP A647, goat anti-rabbit A594, and goat anti-mouse A488, all at 1:500 dilutions. All imaging was performed according to the procedure above using laser scanning confocal microscopy. All image processing was done in ImageJ and Adobe Photoshop.

### 2.7 Sensory dendritic assay

In the final experiment, 10-15 virgin females from the *ppkGal4*; UAS *cd4:tdTOMATO/cyo* line were crossed with 5 males from each of the UAS-TRiP lines. A microscope slide was prepped for larvae imaging by placing two 1.5 Slip-Rite coverslips with a 1mm gap between them on the slide using clear nail polish. A solution of 15% chloroform in mineral oil was spread on the slide (to immobilize larvae) and the third-instar larvae

were placed in between the coverslips. A final 24x50 0.13-0.17mm thick cover glass was used to compress the larvae to the slide and minimize any movement.

The larvae were imaged through the cuticle to the underlying sensory neurons using scanning laser microscopy, as detailed above. All images were taken from A4-A6 segments of the larvae, with no more than 2 sensory neurons from each animal included in analysis.

Sensory neuron images were processed using ImageJ. Each image was manually adjusted to threshold and skeletonized using the ImageJ skeletonize plugin. The resulting skeleton image was assessed using the corresponding analyze function in ImageJ to generate branch information and results tables. From the results table, the total number of branches, average branch length, number of junctions and maximum branch length were recorded. Total branch length was then calculated for each sensory neuron by multiplying average branch length by total number of branches. For both the total branch length and the number of junctions, outliers statistical testing was done to determine any outliers using the ROUT method in Prism, which is similar to Grubb's method<sup>15</sup>. Once outliers were excluded from the data, a one-way ANOVA was performed followed by a Dunnett's multiple comparison test.

## 2.8 Statistical analysis

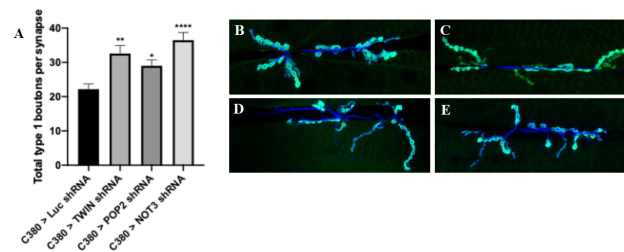
All data was recorded in Microsoft Excel and graphed and statistically analyzed in GraphPad Prism. Results were considered to be statistically significant at  $p < 0.05$ . Results shown throughout the study are mean  $\pm$  SEM. n.s. = not significant, \*  $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$ , \*\*\*\* $p < 0.0001$ .

## 3 RESULTS

### 3.1 Pre-synaptic knockdown of NOT3, POP2, and TWIN significantly increased synaptic size

This experiment was confirming the results from the previous Barbee lab screen in determining whether NOT3, POP2, and TWIN play a pre-synaptic role in the development of the synapse. A motor neuron specific Gal4 driver (C380-Gal4) was used to drive expression of a short hairpin RNAi (shRNA) transgene targeting each of the genes. I analyzed synaptic bouton number at the neuromuscular junction of the A3 segment and statistically analyzed each data set for significance. All 3 of the genes demonstrated no significant differences in variance from the post-hoc tests and had significantly more boutons per synapse than the control sample (Table 1). A small-bouton phenotype was observed in the synapses from the knockdown of POP2, TWIN, and NOT3 that contributed to their significantly higher bouton counts (Figure 2, panels C-D). The greatest increase

in synaptic size was found in the knockdown of the TWIN gene. The smallest, yet still significant increase in synaptic size was found in the knockdown of the POP2 gene (Figure 2, panel A).



**Figure 2.** Green staining represents the staining of anti-DLG at the terminals of the post-synaptic type I boutons. Blue staining represents the anti-neuronal HRP pre-synaptic terminal staining. (A) Graphical representation of the total type 1 boutons per synapse for each genotype in the pre-synaptic knockdown. All 3 experimental knockdowns displayed a level of significance compared to the control. (B) Representative image of a synapse of C380 > LucIII shRNA. (C) Representative image of C380 > NOT3 shRNA synapse. (D) Representative image of C380 > POP2 shRNA synapse. (E) Representative image of C380 > TWIN shRNA synapse.

### 3.2 Post-synaptic knockdown of POP2, TWIN, and NOT3 significantly increased synaptic size

A muscle specific Gal4 driver (sco/cyo;24BGal4/Tm6b) was used to drive expression of a shRNA transgene targeting each of the genes. I analyzed synaptic bouton number at the neuromuscular junction of the A3 segment and statistically analyzed each data set for significance. Observations of the synapses from the post-synaptic knockdown of POP2, NOT3, and TWIN show a small-bouton phenotype that mirrors the one seen previously in the pre-synaptic knockdown experiment (Figure 3, panels D-E compared to panel B). The greatest increase in size of the synapse was seen with the knockdown of TWIN and NOT3, whereas POP2 had a smaller, but still significant increase (Figure 3, panel A).

### 3.3 TWIN and NOT3 are concentrated in the pre-synaptic terminal

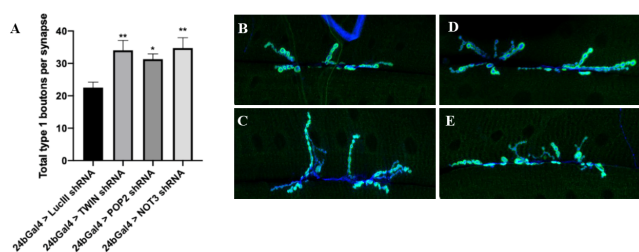
The third aim of this experiment was to determine if NOT3 and TWIN localized to the NMJ. Third-instar larvae from the control CantonS line were dissected and stained using antibodies specific to CCR4 and NOT1 and subsequently analyzed for concentration of expression. Antibodies were available for NOT1 and TWIN. NOT1 was used as a substitute for the staining of NOT3 and there was no data collected on the localization of POP2 due to lack of an available antibody. Both anti-TWIN, anti-NOT1, and anti-HRP showed the exact

**Table 1** Statistical values and mean bouton count for each genotype in the pre-synaptic knockdown.

Genotype	Mean # Total Boutons	Standard Deviation	P Value
C380 > LucIII shRNA	22.18	6.287	N/A
C380 > TWIN shRNA	32.59	9.612	0.0014
C380 > POP2 shRNA	29.00	7.357	0.0487
C380 > NOT3 shRNA	36.47	9.220	<0.0001

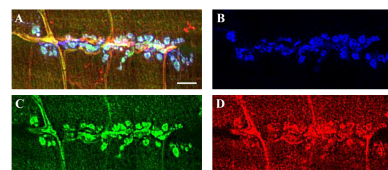
**Table 2** Statistical values and mean bouton count for each genotype in the post-synaptic knockdown.

Genotype	Mean # Total Boutons	Standard Deviation	P Value
24bGal4 > LucIII shRNA	22.56	6.572	N/A
24bGal4 > TWIN shRNA	34.06	12.23	0.0065
24bGal4 > POP2 shRNA	31.31	6.519	0.0194
24bGal4 > NOT3 shRNA	34.75	12.77	0.0017



**Figure 3.** Green staining represents the staining of anti-DLG at the terminals of the post-synaptic type I boutons. Blue staining represents the anti-neuronal HRP pre-synaptic terminal staining. (A) Graphical representation of the total type 1 boutons per synapse for each genotype in the post-synaptic knockdown. All 3 experimental knockdowns displayed a level of significance compared to the control. (B) Representative image of a synapse of 24bGal4 > LucIII shRNA. (C) Representative image of 24bGal4 > NOT3 shRNA. (D) Representative image of 24bGal4 > POP2 shRNA. (E) Representative image of 24bGal4 > TWIN shRNA.

same staining pattern, indicating that there is enrichment in the pre-synaptic terminal of both CCR4 and NOT3 (Figure 4, panels B-D). There was much more robust staining observed with NOT1 compared to CCR4 (Figure 4, panel C compared to panel D). Both proteins are also expressed in muscle, but the staining was shown to be much weaker in this location (Figure 4, panel A).

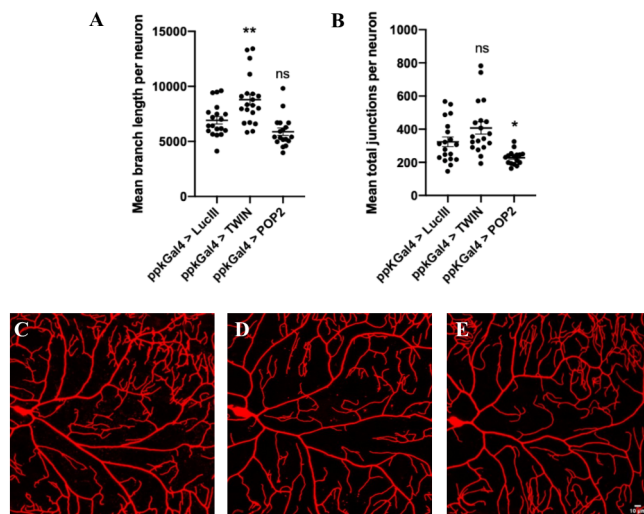


**Figure 4.** Colocalization of deadenylation proteins in CantonS at the NMJ. (A) Merged channels of staining on synapse. (B-D) Larvae were stained with antibodies targeting HRP (blue), NOT1 (green), and CCR4 (red).

### 3.4 TWIN increases sensory dendrite growth and POP2 decreases sensory dendrite complexity

The final goal of this paper was to determine if NOT3, TWIN, or POP2 had any effect in the development of neuron dendrites in *D. melanogaster* larvae. Previous research indicated that *Fmr1* has an effect in dendritic arborization neurons of the body wall<sup>16</sup>. A sensory neuron specific Gal4 driver (*ppkGal4*; *UAS cd4:tdTOMATO/cyo*) was used to drive expression of a shRNA transgene targeting each of the genes. Virgin females from *ppkGal4* were crossed with adult males from each *UAS-TRiP* line and the resulting wandering third-instar larvae were imaged. Sensory dendrites were analyzed for total branch length and number of junctions. Interestingly, there was a significant increase in total branch length in the knockdown of TWIN but not with the knockdown of POP2 (Figure 5, panel A).

There was also a significant decrease in number of junctions with the knockdown of POP2 but not with the knockdown of TWIN (Figure 5, panel B). It should be noted that the cross between ppkGal4 and NOT3 produced no third-instar larvae and was therefore excluded from analysis, suggesting that the knockdown of NOT3 in sensory neurons is second-instar larval lethal.



**Figure 5.** (A) Graphical representation of the mean branch length per neuron of each genotype. (B) Graphical representation of the mean total number of junctions per neuron for each genotype. (C) Representative image of a sensory neuron for ppkGal4 > LucIII shRNA. (D) Representative image of a sensory neuron for ppkGal4 > POP2 shRNA. (E) Representative image of a sensory neuron for ppkGal4 > TWIN shRNA.

#### 4 DISCUSSION

Although Fragile X Syndrome is an overall well-characterized disease, its underlying molecular mechanisms are still unknown. The present study aimed to further characterize some of the suggested genes that could be involved in FXS using *D. melanogaster* as a model.

This research first concentrated on the potential effects of POP2, TWIN, and NOT3 at the neuromuscular junction. This is based on results from a genetic screen conducted in the Barbee lab. The results from the pre-synaptic knockdown of each of these genes demonstrated a significant increase in synapse size, as measured by the total number of boutons present. A small-bouton phenotype was also observed with the synapses resulting from the knockdown of these genes, confirming the previous work's conclusions. Within this significant result, there was variability in how much larger the synapse became with the knockdown of each gene. For example, C380 > NOT3 shRNA showed the most significant effect on the synaptic size at  $p < 0.0001$ . On the other hand, C380 > POP2 shRNA showed a smaller,

yet still significant effect on synapse size at  $p < 0.0487$ . This finding supports previous literature that demonstrates NOT3 having the largest influence on synaptic size compared to the other genes involved<sup>6</sup>. One explanation for the variation observed in strength of phenotype between these genes could be their location and role within the CNOT complex. For example, NOT3 is closely associated with the NOT1 scaffolding proteins whereas TWIN is not directly associated with NOT1 and therefore is further from the center of the complex (see Figure 1). Another explanation could be the different roles that TWIN and POP2 have in the CNOT complex compared to NOT3. NOT3 plays a much more integral role in the functioning of the deadenylation complex, whereas TWIN and POP2 act more as accessory proteins which help with the deadenylation process<sup>17</sup>. These findings in the variation of how these proteins function indicate that there is still much more to be learned about the details within the functioning of CNOT on the poly-A tail.

As a primary deadenylation complex, CNOT is comprised of many proteins, each of which performs a distinct role. Within the CNOT complex, TWIN and POP2 are catalytic subunits part of the core complex<sup>18</sup> NOT1 is the scaffold protein to which they attach, and therefore without NOT1 neither of the catalytic subunits can function. CCR4 is believed to interact with PABP1 to remove it from the poly-A tail so that all adenosine molecules are completely removed, whereas CAF1 is believed to aid in the overall functioning in the complex without one specific role<sup>19</sup>. The close association of NOT3 with the scaffolding protein NOT1 helps to explain why the knockdown of NOT3 resulted in a much more significant increase in synaptic size compared to TWIN and POP2. It has also been found that POP2 is dispensable for the deadenylase activity of TWIN, as shown in previous studies that CCR4 is the principal deadenylase in the CCR4-NOT complex<sup>20</sup>. This insight gives a better understanding as to why the knockdown of POP2 had the least significant change in synapse size – although still important, it is less critical to the functioning of the complex as opposed to NOT3 and TWIN. These findings reinforce the research that has been done previously on this topic and supports the first aim's hypothesis that there would be a significant increase in synaptic size with the pre-synaptic knockdown of TWIN, POP2, and NOT3.

In order to address the second aim of this experiment, each of the 3 genes examined were knocked down in the muscle of *D. melanogaster*. The post-synaptic knockdown of POP2, TWIN, and NOT3 demonstrated a significant increase in synapse size for each case. Similar to the results from the pre-synaptic knockdown of these genes, the greatest significant increase in synapse size was observed in the absence of NOT3. Likewise, POP2 demonstrated the smallest significant increase

**Table 3** Comparison of total branch length of each genotype.

Genotype	Mean Total Branch Length	Standard Deviation	P Value
ppkGal4 > LucIII shRNA	6917	1471	N/A
ppkGal4 > TWIN shRNA	8793	2256	0.0032
ppkGal4 > POP2 shRNA	5887	1405	0.1458

**Table 4** Comparison of mean total number of junctions of each genotype.

Genotype	Mean Total Number of Junctions	Standard Deviation	P Value
ppkGal4 > LucIII shRNA	324.2	126.5	N/A
ppkGal4 > TWIN shRNA	407.2	160.1	0.0789
ppkGal4 > POP2 shRNA	228.2	42.64	0.0484

in synapse size. One implication from the findings in experiments 1 and 2 is that NOT3, POP2, and TWIN are all important to the regulation of mRNA on both sides of the synapse. The observed overgrowth at the synapse can be attributed to the upregulation of translation with the knockdown of these genes. It can also be suggested that local translation is occurring on both sides of the synapse, and therefore a dysregulation is causing synaptic overgrowth. It is unsurprising, then, to conclude that translation needs to be regulated on both sides of the synapse in order to control synaptic growth. This finding supports the hypotheses of aims 1 and 2.

Based on a role for the deadenylation complex in NMJ development, I next wanted to ask if any of these proteins were enriched locally at the synapse. The performed immunohistochemistry procedure addressed the third aim of this study. It was concluded from the resulting images that that TWIN and NOT3 colocalize at the pre-synaptic terminal of the NMJ. The NOT1 antibody was used instead of NOT3 due to ready availability. However, the staining of NOT1 can be used as a representative of NOT3 localization because both genes are highly correlated with each other as part of the scaffolding portion of the deadenylation complex.

Unlike the previous two experiments, this colocalization assay does not lend information on the molecular interactions of these genes. Rather, the focus of this assay was simply to observe where these proteins are strongly localized. The above data suggests that the presynaptic function is local in axon terminals. It is not only important to examine the functionality of these

genes; it is also important to look at their patterns of expression. Although it is difficult to definitively analyze the resulting images shown in Figure 4, the clear staining of NOT1 demonstrates its colocalization at the pre-synaptic terminal. In the merged image it becomes apparent that its staining matches that of anti-HRP on the axon (Figure 4, panel A). The staining with CCR4 was not as clear, making it more difficult to draw a strong conclusion on its colocalization specifically in the pre-synaptic terminal. While it is shown to match the staining of anti-HRP, unlike NOT1 it does not demonstrate a robust expression at the synaptic boutons. Both proteins are also expressed in muscle, but at lower levels (Figure 4, panel A). The information gathered from this experiment indicates that there is specific and significant localization of TWIN and NOT1 at the NMJ which helps pave the way for future studies.

There have been no previous studies performed examining the effect of these genes on sensory neurons in *D. melanogaster*. Sensory neurons were imaged through the cuticle of third-instar larvae. Sensory dendrites were analyzed for both total branch length as a measure of the size of the neuron, and number of junctions in the dendrites as a measure of complexity. Interestingly enough, the results showed a significant increase in total area of the neuron only with the knockdown of TWIN, suggestive that TWIN is a negative regulator of dendrite morphogenesis. Conversely, only a significant decrease in total number of junctions per synapse was observed in the knockdown of POP2. This difference in results suggests that TWIN may be more important for the regulation of mRNA in sensory neuron development,

whereas POP2 does not play as integral a role in the deadenylase complex. It is worth mentioning that there were no results from the cross between *ppkGal4* and NOT3. No third-instar larvae developed from that cross, although first- and second-instar larvae were observed. Therefore, it can be concluded that the knockdown of NOT3 in sensory neurons is second-instar larval lethal.

There are many implications within the result of the sensory neuron experiment, including what it could mean for the role of these genes in the overall development of the animal. The conclusions from this experiment support the idea that the most significant change in larvae development occurred with the knockdown of NOT3. This means that NOT3 can be inferred as a critical protein to the deadenylation complex and that the complex cannot function without it. There is still much more to be discovered about how these genes take exhibit such an effect on the development of sensory neurons.

## 5 FUTURE DIRECTIONS

There are a few areas of improvement within the experiments outlined above. When imaging the pre- and post-synaptic NMJs, it was difficult to ensure consistency in counting each bouton. There is no reliable, automated system to count boutons at the synapse, and discovering one in the next few years would help to eliminate any human error with this process. Within the process of choosing a muscle driver to use for this experiment, there were some issues to finding one that worked well with each of the UAS-TRiP lines. For example, one muscle driver originally chosen for this experiment was MHC-Gal4. Once the crosses were set up, however, it was found that it was third-instar larval lethal. The muscle driver that was eventually chosen for this experiment is not ideal due to the declined health of the flies from the mutations on chromosomes 2 and 3. Future studies from this experiment should consider attempting the use of other muscle driver lines to increase the health and accuracy of the results. Another caveat with these studies is that there was no way to be certain that the knockdown of the target genes was successful. In a repeat of this experiment, it would be worthwhile to employ a similar procedure to the immunohistochemistry procedure used in experiment 3 to ensure that there was no significant concentration of the targeted gene at the neuromuscular junction after knockdown.

Lastly, within the sensory neuron assay, there have been suggestions of other programs that may have the capability to better quantify dendrite area with a more accurate reading of total branch length. In the future, studies could try different techniques for quantifying total branch length and number of junctions to test which one is the most efficient and accurate. For example,

one considered method was to try outlining the dendrites by hand and then analyzing the resulting skeleton. Although it may not be conducive for efficiency, this method may lend knowledge to a more accurate technique to quantify total branch area and number of junctions.

In conjunction with the results of the sensory dendrite experiment, one potential future study could be on the colocalization of TWIN, POP2, and NOT3 within sensory neurons. This could provide information not only on how these genes are affecting the dendritic area and complexity, but also how they are expressing in these areas. It would be worthwhile in future studies to perform staining of all 3 genes in a control NMJ. It is also apparent that better antibodies need to be determined to better characterize the localization of CCR4.

Finally, a proposed follow-up study could test other components of the deadenylation and decay pathways play similar roles in the development of *D. melanogaster*. For example, some of the genes involved in the de-capping process of mRNA may also influence synapse size or sensory neuron complexity. Each of these potential studies would contribute to our knowledge of genes involved in FXS and could go so far as to lead to therapeutic possibilities.

The work outlined above only begins to characterize NOT3, POP2, and TWIN as critical proteins in animal development relating to deadenylation. There is still much to be done regarding the characterization of these genes in the context of the FXS model, including many potential future studies. As mentioned previously, one such study could draw on the results from the immunostaining experiment and not only repeat the procedure but include antibodies to better stain CCR4 and an antibody to stain CAF1 as well. This would contribute to an understanding of the localization of these genes at the NMJ. Overall, this work continues to support and add to the growing research being done on the molecular basis of Fragile X Syndrome which will hopefully eventually lead to better treatments for this genetic disease.

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## 7 EDITOR'S NOTES

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# Serving with Pride: Military Experience and the Formation of the Queer Female Identity in Mid-Century America

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## Abstract

At the inception of World War II, the United States military adapted to include women within its ranks with the creation of the Women's Army Corps. Likewise, psychology's implementation into military procedures legitimized systematic exclusion and removal of queer persons seeking military involvement. Such factors resulted in a particularly unique environment for queer servicewomen. The birth of the Cold War brought about a new wave of heterosexual expectations that forced queer individuals in the U.S. military even further into the closet. This project seeks to uncover how gender and sexuality expectations placed upon queer women serving in the World War II and early Cold War U.S. military influenced them in their lives after service. The conclusion of this research is that the military's clamping down on sexuality, paired with the all-female environment of women's units, encouraged queer women to more boldly assert their sexuality in the years following their service, which propelled the gay liberation movement forward. Their work in the post-service years, while not always manifesting as clear-cut activism, broadened the movement in often unexpected ways.

**Keywords:** Sexuality, gender, U.S. military, gay liberation, World War II, Cold War

## 1 INTRODUCTION

Late into the night at Walter Reed Army center on September 1, 1962, a woman sits at a desk, isolated. She stares at the blank page of her diary. Having spent the past few months immersed in a sea of beige and green, she is awash with a drowning sensation that has become all too familiar<sup>1</sup>. Finally, she picks up a pen. She writes, "I want to meet some nonmilitary people – crazy people, imaginative idiots, some eccentric individualists, outcasts, gay kids. Oh, I want to see gay kids..." She finishes up her entry for the day before setting the pen back down. Over the past few months of her military service, her diary functioned as an outlet in an environment that had proven to be hostile to people like her: homosexuals. She picks up the pen– this time with a breakable force. She pushes the pen back into the paper before she can fully process what she is doing and begins forming thick and heavy markings, deep enough to indent the paper. Rhythmically, almost as if a force outside her body takes over her, she scratches a singular word underneath her latest entry. Finally, she stares down at the paper. The word stares back up at her in deep blue ink: "No"<sup>1</sup>.

United States military veteran, Lilli Vincenz, has a

story that bears resemblance to other queer servicewomen who served their country in the Cold War, despite pointed discrimination<sup>2</sup>. The Cold War military environment was unforgiving of anyone who existed outside of gender and sexual norms, which made for a distressing environment for queer women. Nevertheless, despite the societal persecution that Vincenz and other servicewomen like her faced, they persisted.

Vincenz's story reflects the anti-homosexual policies that began back in World War II. During this time, the United States saw homosexuality as a sexual disorder. Simultaneously, the military increased female participation within the military. The place of queer women in the military was particularly unique because, not only were women expected to uphold societal standards of femininity, but they were also expected to maintain an appearance of heterosexuality. World War II and the Cold War posed a series of difficulties for queer servicewomen in ways that were defined by gender stereotypes. In the World War II era, queer female stereotypes combined with traditional gender expectations and resulted in challenges posed to queer women whose appearances or behavior existed outside of traditional standards of femininity. Women in military leadership perceived to be "Butch" presenting were

removed from the military because of physical expressions that existed outside of what was acceptable for a woman, while queer women deemed to be “femme” presenting could enter and serve in secret.

The Cold War military leadership was more forceful in their policies against homosexuality and posed challenges to LGBTQ+ women, regardless of their gender expression. The Cold War gave rise to a unilateral effort to remove queer women, whether they were traditionally feminine or not. Even though government removal efforts were united in the Cold War era, it is clear that their methods of discovery and removal still hinged upon gender expectations that served to define the experience of queer servicewomen. Queer women who were able to maneuver around these hardening heterocentric policies in order to serve still had to exist within a hostile environment.

My thesis fills a gap in past historical scholarship by examining the experiences of LGBTQ+ women who served in the military during World War II and the Cold War in order to unearth the ways in which queer women’s military service empowered them to become leading forces in the gay liberation movement. While other scholars have discussed LGBTQ+ women in World War II and the Cold War, they do so in broad brush strokes without specifically highlighting queer servicewomen. Scholars largely discuss LGBTQ+ military women in the context of larger conversations of military life instead. The research that has been presented by historians on the topic often uses the experience of queer women as a framework to diversify the conversation of sexuality that is predominately male focused, or as a way of adding nuance to the experience of women more generally within the military.<sup>34</sup> To this end, scholars have yet to fully differentiate the experiences of queer servicewomen from that of other military personnel during the World War II and Cold War era. The military became a solitary place where women could meet other women without the pressure of men. Further, the military’s explicitly discriminatory policies created a perfect enemy for queer women to rally against. This discrimination that queer women experienced from within the restrictive military environment inspired them to take on more active roles within the queer community once they left the military. The secret networks that formed within their ranks helped create the post-war networks that served as a partial groundwork for the gay liberation movement.

## 2 RESEARCH BODY

In order to demonstrate the pushback that queer women expressed when they left the World War II and Cold War environment and rejoined civilian life, it is important to unpack clear examples of women who did so. Pat Bond serves as a great introductory resource as

a queer servicewoman who served in World War II. She bore witness to queer purges in the WAC (Women’s Army Corps), and went on to write and perform a skit called “Murder in the WAC.”<sup>5</sup> In this 1982 skit, she tells the tale of “one of the first lesbian martyrs,” Helen Hunt. Military leadership discovered Hunt’s sexuality when they went through her mail and found pictures of her kissing other women. Bond described what followed:

There was a terrible silence as every day one of us went up against the court-martial. And one day Helen, who was 20 years old, went up to the sixth floor where she lived and jumped out the window. . . . And the thing that haunts me still is that her parents will never know why their child died. . . . And finally I went to an officer I trusted, Captain Van, and I said ‘Captain Van’— and I can still feel the winter wool when I put my hand on her shoulder and see my tears dripping off her palace of clean emblem she wore on her collar— I said, ‘Captain Van they’re gonna kill us all. I know they are. What have we done? Why? What have we done? Help me. Help us.’ And the next day she was transferred out. And Captain Saxon and Captain Burdges conducted all those summary court-martials. . . . I mean, at that age when you’re just discovering your sexuality, to be told that everything you are is rotten, filthy and dirty does something to you. Well- then everyone was sent home for formal court-martial. . . . Then finally it was over and we were let go. . . . They have not changed and they will not change. And so at least I can say— Captain Martha Saxon, Captain Mildred Burdges, I indict you for murder in the women’s army corps<sup>6</sup>.

Pat Bond spent the years following her military service trying to deconstruct the military’s treatment of queer women within its ranks. She is known as an actress and comedian who tackles sexuality, specifically through her role in the 1977 movie, *The Word is Out*, where she talked in depth about military persecution<sup>7</sup>. In her speech “Murder in the WAC,” she eloquently sews together soft comedic elements of the military service with the firm condemnation of how the military treated queer women who served. This is a primary example of post-service military women publicly holding the military accountable for its actions. Her vocalization of her military experiences helped to create a greater understanding of how the military partook in sexual discrimination. Bond serves as a clear example of how queer women worked as activists when they left the World War II and Cold War military environment and rejoined civilian life. Rather than returning to their lives of secrecy, queer women often took the opportunity to

push forward gay liberation efforts, intentionally or not. The methods that the women took were not always as clear-cut as Bond; not all forms of activism look the same. Instead, queer women confronted parts of society that were largely heterosexual and redefined them to be queer-inclusive. The emergence of seemingly unrelated queer-positive facets of society, like LGBTQ+ literature and magazines, or queer public spaces, or even queer-friendly psychological research—turned out to be vital for the creation and later acceptance of the larger gay community in the United States.

## 2.1 Escaping the Well of Loneliness: Queer Literature

Queer military novels and pulps dispersed during the World War II and Cold War eras helped not only to push along the formation of the queer identity within the military, but also helped strengthen the queer identity for the years after. Literature focusing on LGBTQ+ women, like *The Well of Loneliness* and *Women's Barracks* validated queer women and encouraged the growth of communities in the military.

The closing words of the 1928 novel *The Well of Loneliness* by Radclyffe Hall voiced the feelings of queer servicewomen at the end of World War I. Stephen, a young lesbian, exclaims “Acknowledge us, O God, before the whole world. Give us also the right to our existence!”<sup>8</sup>. It is not difficult to see the similarities of Stephen’s World War I experiences in the novel to those queer women serving within the World War II United States military. Stephen grows up in a world where she is restricted by gender expectations. She desires to follow in the image of her father and take on more “masculine” habits, but her mother insists that she instead don “soft dresses and sashes, and ribbons”<sup>8</sup>. When her mother finds out about her love for another woman, she banishes her, and Stephen moves on to join the French Army Ambulance Corps during World War I. There she meets Mary, discovers that they share similar identities, and agree to live together as a couple once the war is won. However, the postwar years are not at all what they hoped and the two become increasingly isolated. The book wraps up with Stephen aching to be given the chance to live a life beyond her personal “well of loneliness”<sup>8</sup>. This isolation and suffering stems from societal opposition and othering of not only homosexual individuals, but also those who did not fit within assigned gender categories. The path that Stephen took, joining the military and carrying feelings of sexual isolation, is comparable to the paths that queer military women walked in their service to the United States in the early to mid-19th century.

The themes presented in *The Well of Loneliness* prompted backlash in the United Kingdom, where it was originally published. Hall’s semi-autobiographical

book was banned in England and not put back into print until 1959<sup>9</sup>. In the United States, however, the book survived attempted bans. Once published in the United States, *The Well of Loneliness* gained particular notoriety among servicewomen during World War II.

As a work of fiction, *The Well of Loneliness* gained popularity within the queer community because it validated homosexuality. It became an under-the-table marker of sexuality that could be circulated safely among one’s peers. For many queer women, the book was their first encounter with descriptions of women like themselves. For example, Del Martin, a co-founder of the Daughters of Bilitis—one of the first American lesbian political organizations—explained that *The Well of Loneliness* was “the first time she was able to put a name to what she had been feeling”<sup>10</sup>. Military women particularly saw themselves in the novel. Whether the servicewoman read the novel prior to enlistment, or during her service, the life of protagonist Stephen legitimized queer servicewomen. John D’Emilio, in *Sexual Politics, Sexual Communities* writes that “*The Well of Loneliness*... created an almost magical aura around military life through its description of the experience of Stephen”<sup>10</sup>. He ties this to the later United States Women’s Army Corps and argues that readership of this book helped make the World War II WAC a “quintessential lesbian institution”<sup>10</sup>. In other words, the existence of the book solidified stereotypes of the WAC hosting queer women, which only spurred women to want to join the service all the more. As such, *The Well of Loneliness* not only inspired queer women to join the United States military during World War II, but it also normalized the female military queer identity.

Helen Harder, World War II servicewoman veteran, confirms this point in her oral history with scholar Allan Bérubé. She tells Bérubé that a fellow servicewoman showed the book to her and that “I [she] identified as Stephen, absolutely. It was a beautiful, beautiful book and a beautiful sadness”<sup>5</sup>. Mary Crawford, a World War II queer veteran herself, reiterated this sentiment and explained how the book was a way to express oneself in a way that wouldn’t draw unwanted attention from military leadership; “I also didn’t want to say that I was [queer], but nobody objected to our reading a book”<sup>11</sup>. *The Well of Loneliness* served as a way for queer military women to not only better understand themselves, but also helped them identify with the queer community through the circulation of the novel.

Yet, as much as queer servicewomen favored the book, military leadership feared it. The book itself was dynamic in the way it was understood by people of different backgrounds. Here was a story of a young butch woman, who entered the military and “corrupted” another fine young woman, only to have both of them then leave the war to live out their lesbian fantasy. This kind of story, though set in World War I, fueled the fear that

the World War II WAC environment would encourage homosexual tendencies in women. This fear stemmed from the fact that war was a place where women solely lived with other women and took on a traditionally “male” military role. Such a position would confuse them into behaving like Stephen and Mary in *The Well of Loneliness*. Therefore, to have such a book in the hands of young servicewoman posed a danger. Ownership of the book was a clue of one’s sexuality. Crawford, for example, had to steal a copy from a drawer full of medical journals<sup>11</sup>. So while the book offered validation for queer women, they also had to find discreet ways to obtain and share the novel. The United States went on to take a more restrictive stance on thematically similar novels, like *Nightwood*, by redacting large sections, including parts discussing homosexuality within the military, to counteract queerness in the World War II military<sup>12</sup>.

After World War Two, the United States experienced a “golden age” of lesbian pulp novels<sup>13</sup>. These novels most often took place in female-only environments. In the years following the mighty World War II, what better setting was there than the female-only environment of women’s military regiments? Illustrative of this point is Tereska Torres’ 1950 story, *Women’s Barracks*. Torres’ autobiographical work describes the romantic encounters that Torres and her military friends encountered during World War II<sup>13</sup>. Interwoven with the tales of heterosexual adventures was a cast of sexually diverse characters who did not shy away from same-sex relationships.

*Women’s Barracks* became the most famous lesbian pulp to be published in this era, selling four million copies in the United States alone<sup>14 15</sup>. The success of *Women’s Barracks* and others like it demonstrates the popularity of the “military lesbian” trope of the time. Such a trope succeeded because it offered solace to queer servicewomen and helped military queerness take root within the queer community. Within the rising lesbian pulp genre, queer women across the United States could add military-focused narratives to their representative collections.

The literature that came out during this time, with a sexually diverse cast of military women, is important because it demonstrates how queer women focused in on military stories, and how that played a larger role in catalyzing the gay liberation movement in later years. Yvonne Keller validates this in her description of the influences of lesbian pulp fiction:

[Lesbian pulps] are important to lesbian studies because their truly impressive quantities helped create the largest generation of self-defined lesbians up to that point, a group of women who would go on to make history as they, alongside others of non-dominant sexu-

ality, midwived the largest gay/lesbian/queer movement in the United States to date<sup>14</sup>.

The fact that one of the most popular sections of queer literature centered in on military queerness demonstrates how big of an influence the underground queer military environment had in the years following World War II and leading up to the gay liberation movement.

After World War II, *The Well of Loneliness* circulated more widely. Lillian Faderman argues that *The Well of Loneliness* was “the quintessential lesbian novel . . . that helped to form self-concepts among the young. . . some of those who were hungry for any discussion or information about their secret life and could find no other source were very affected by the most obvious literary model”<sup>16</sup>. She describes the book as a force that helped in the formation of the greater lesbian “consciousness” that allowed for the growth of a lesbian community<sup>16</sup>. In this case, *The Well of Loneliness* offered an understanding of sexuality that queer servicewomen struggled to find otherwise with the repressive military leadership.

The repeated appearance of both *The Well of Loneliness* and *Women’s Barracks* within popular lesbian magazines also reflects the influence of queer military literature. For example, *The Ladder*, a popular lesbian magazine that ran from 1963 to 1966, frequently discussed *The Well of Loneliness*<sup>17</sup>. In the July 1963 issue, Donald Webster Cory described *The Well of Loneliness* as being “the *Uncle Tom’s Cabin* of homosexuality... the voice of those who had for years been voiceless”<sup>18</sup>. The comparison here to *Uncle Tom’s Cabin* is profound, for this novel is often cited as contributing to the Civil War<sup>19</sup>. Likewise, *The Well of Loneliness* was a force in the civil rights movement for queer women and men. Moreover, the first lesbian magazine, *Vice Versa* also reviewed *The Well of Loneliness* in one of its initial issues in 1947. The review by Edythe Eyde praises the book, stating that it “ carries a powerful message—a plea against the senseless persecution and intolerance. . . an incentive not to give way to despair, no matter how bitter the persecution. To read this great novel is a great emotional experience and a stimulus toward leading a better life”<sup>20</sup>.

*The Ladder* also frequently discussed *Women’s Barracks*<sup>21</sup>. A significant discussion of *Women’s Barracks* integrates it with *The Well of Loneliness* and other similar novels in the article, “Five Minority Groups in Relation to Contemporary Fiction,” by Valerie Taylor. Taylor focuses on the influence of fiction over public opinion. She points out that although “we buy stories to be entertained,” the unintended results are that “we learn from them without meaning to”<sup>22</sup>. Notably, she points out the broad political impacts of minority-focused fiction:

Each of us here is interested in legal and social justice for at least one group of persons, an increasingly articulate group, and books are one means through which the general pub-

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lic can be informed and influenced. There are other and perhaps better ways. Direct political action is one. But some of us happen to be writers, and we must use the tools at hand<sup>22</sup>.

Taylor is pointing out that an avenue for political dissent is not always through traditional means of picketing and marching. Writing fiction is powerful in changing the minds of others. She then goes on to bring up *The Well of Loneliness* as another example. Taylor's discussion suggests that queer women of the time considered queer fiction—which often focused on military service-women—as solidifying the queer female community and advancing social change.

### 2.2 Queer Magazines

Lesbian magazines circulating at the time discussed military participation and exclusion outside of the literary realm. Magazines, such as *The Ladder* or *Vice-Versa* disseminated the stories and experiences of queer women to raise a greater consciousness of the queer female identity. Likewise, queer servicewomen themselves, like Edythe Eyde and Lilli Vincenz, got involved directly in the creation of such literature.

A prominent example of the military voice having been circulated was in the November 1965 issue of *The Ladder* that featured queer servicewoman, Jean, on the cover. Printed in the issue was her interview, conducted by both Barbara Gittings and Kay Tobin. In the interview, the very first question that Gittings asks of Jean was “how does a girl raised in a small town in Ohio, as you were, find out about gay life?” to which Jean responded, “Well, if she happens to join the service, that's one way!”<sup>23</sup>. Her comment suggests that queer women who joined the military service were secretly able to gain stronger understandings of their own sexuality by doing so.

As the interview progressed, Jean went on to tell stories of fellow women removed for homosexuality and explained the circumstance of her own discharge. Officials discovered her sexuality when a straight woman, who had integrated herself into her largely queer friend group, reported them to the Office of Special Investigations. Because of the accusation, she and her friends were called in and had their belongings searched. In the interview, she explains “The men searched everywhere—even in my mattress and pillow. And then they told me to unlock my locker. So I did. And I handed them the book *The Well of Loneliness* and I said, ‘I guess this is what you want, isn't it?’”<sup>23</sup>. Because they could not discharge her just for owning the book, they took her into their office and questioned her for twelve hours. She eventually relented<sup>23</sup>. After her service, she worked as an assistant editor for the *Gayola Gazette*, a newspaper that a group of her friends made together but never

officially published. For context, *gayola* is a term for bribe money paid to the cops by queer individuals in order to avoid arrest. Gittings, late in the interview, asked Jean whether or not she changed people's minds about sexuality, to which Jean responded “Let's say I've opened up new facets of liberalism! Often, they haven't thought much about homosexuality. So their scope has been widened”<sup>23</sup>. Such an articulation is accurate; often it was up to queer women like Jean to bring sexuality into the liberal conversation.

Jean's interview is relevant on several fronts. First, as an individual, Jean symbolizes a life-path that was not uncommon for women entering the military. Women entered the service not knowing what the term “homosexual” meant, and through exposure to other queer individuals and queer literature, they were able to better understand their sexuality. With this in mind, upon leaving the military many went on to “change the opinions of straight persons”<sup>23</sup>.

Beyond this, her story also reiterates the importance of *The Well of Loneliness* within the military. If Jean entered the military unaware of her sexuality, she left it with *The Well of Loneliness* hidden in her locker. Meeting other similar women who exposed her to queer literature helped her orient her sexuality. Likewise, when military leadership discovered the novel, it signaled to them that they needed to question Jean further. Alongside this, the way in which Jean talks about *The Well of Loneliness* indicates how well known the book was in the community. She offers no explanation of the book, for she assumed that her readers would know the novel and its relevance. This points yet again to the book having been both important in the solidification of a queer military identity and having later played a role in the solidification of queer military women within what would become the gay liberation movement.

Yet another facet of Jean's story is the very fact that *The Ladder* printed her interview in the issue that they did. This issue hosts three major articles; Jean's interview, “A Brief of Injustices,” and “Homosexual Voting Bloc Puts Pizzazz in Politics,” all politically salient topics<sup>23</sup>. The general theme across all of these articles was government injustice. As such, printing such an interview had an agenda far larger than simply entertaining readers. The goal of publishing this article, specifically in this issue, was to catch the reader's attention, make them empathize with Jean's experience, and provoke action within the queer community.

*The Ladder* often discussed homosexual exclusion policies. In the February 1961 issue, psychologist Lee Steiner wrote a harsh response to the article “Frigidity and Femininity,” by Dr. Arthur J. Mandy. Mandy's work argued that when women believe that they can take on roles, like being “soldiers in the army”, these women end up being “unwilling to become dependent upon their husbands” and that, because of it, “they themselves want

to pursue the sex act. They want to feel as aggressive as men"<sup>24</sup>. Mandy warns against such behavior as encouraging homosexuality. Steiner responded "I, personally, do not agree with this psychiatrist's definition of the role of women... It would seem to me to be simpler to say that femininity is anything that females like to do"<sup>24</sup>.

In the end, Steiner reiterates that psychological research like Dr. Mandy's is inconclusive. In doing so, she still recognizes the need for unbiased research on same-sex attraction. To unearth such *real* research for the community, she instead tells queer readers of the magazine that they "are the building blocks upon which such research would be built" and instruct, "you are the ones who must initiate, carry on, and publish such research."<sup>25</sup> Such an article challenged the psychological arguments used to exclude queer Americans from the U.S. military. Steiner contradicts opinions that when women take on non-conformist gender roles, their femininity is threatened, and they become vulnerable to homosexual corruption. She debunks the research that justifies such explanations and challenges the queer community to rise up and conduct their own internal research. She asks queer women to replace the military's definition of homosexuality as undesirable with one that accepts a broader range of sexual identities.

*Vice-Versa* paid equal attention to queer women in the military. In the September 1947 edition, the magazine ran an article titled "Here to Stay," that focused on the lasting presence of a queer community that will no longer be comfortable being marginalized. Instead, the queer community is "here to stay." The article goes on to bring advocacy to the conversation with the impacts of World War II. "Here to Stay" states that, "the war, by automatically causing segregation of men from female company for long periods of time, has influenced fellows to become more aware of their own kind"<sup>24</sup>. As such, the article suggests that the military community of same-sex cohabitation could impact understandings of sexuality. In the same article, mention of *The Well of Loneliness* is yet again brought up so as to say:

With such knowledge being disseminated through fact and fiction to the public, homosexuality is becoming less and less a taboo subject, and although still considered by the general public as contemptible... I venture to predict that there will be a time in the future when gay folk will be accepted as part of regular society<sup>24</sup>.

Long after *Vice Versa* stopped printing new magazines, *Vice Versa* author, Edythe Eyde, said in an interview that this article in particular was "one of my favorites" because "it has all come to pass... It makes me feel like a fortune teller"<sup>26</sup>. This article, written in 1947, predates the gay liberation movement, so such optimistic think-

ing about the future of the queer community must come from a person dedicated to fighting for it. In this article, we again see the magazine running other articles with more progressive viewpoints that optimistically envision a brighter future for queer individuals; the author cites *The Well of Loneliness* as at least partially responsible for diminishing the stigma against homosexuality, and describes the military environment as a place that solidified identity for many queer individuals. The September 1947 article in *Vice Versa* validates that the military experience helped in the formation of a community that, in turn, was prepared to take on political activism in the gay liberation movement.

### 2.3 Edythe Eyde as Lisa Ben

*Vice Versa's* importance goes far beyond what is held within its pages, and holds relevance within the context of its author. The magazine's creator, Edythe D. Eyde, worked within the military herself at a War Dog training center in 1944<sup>26</sup>. After she left, she worked at RKO studios in 1947, where her boss told her that "You won't have a heck of a lot to do here, but I don't want you to knit or read a book. I want you to look busy"<sup>27</sup>. And so she began to write a magazine for queer women titled *Vice Versa* because "in those days our kind of life was considered a vice. It was the opposite of the lives that were being lived—supposedly—and understood and approved by society. And vice versa means the opposite"<sup>27</sup>. She wrote *Vice Versa* in her free time and delivered the magazines to members of the community, who, in turn, handed the magazines off to others once they had finished reading. Such a process was necessary at the time because the publication and mailing of a lesbian magazine was illegal in California. When talking about her magazine she pointed out that:

I didn't suppose anything could come out of *Vice Versa* because I knew in those days such magazines could not be sent to the printers and published. So it was just a sort of a gesture of love—of women loving women, and the whole idea of it. It was enthusiasm that boiled over into these printed pages, and I wanted to give them to as many people as possible. It was a way of dividing myself into little bits and pieces and saying, 'Here you are, take me! I love you all!'<sup>27</sup>.

As such, we see the level of dedication that it took to get these issues printed. She couldn't officially publish her magazine. She had to hand type every issue while at work; a risk in and of itself given contemporary concerns over homosexuality. She then had to share the issue with those who would take the time to read it and trust that it wouldn't land in the wrong hands as the copies circulated around. Her aim was to encour-

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age and commiserate with other queer women and in doing so, helped to create a more unified and vocal community.

Eyde also made a point to get involved in the community outside of the magazine. She worked with Jim Kepner, another queer activist, to author science fiction novels throughout the late-1940s and 1950s with queer undertones. A director of the ONE National Gay and Lesbian Archives described their science fiction writing as an undercover outlet to spread more liberal rhetoric; “Some of it was clouded some of it’s not. Kepner and Lisa Ben (a pseudonym for Eyde) weren’t just talking about gay rights, they were talking about feminism, racial equality- the thing is science fiction was a place they could do all that because they were imagining a new world”<sup>28</sup>. During her post-military years, Eyde was able to use science fiction to inform and educate queer individuals through non-traditional methods because it was dangerous to do so in more direct ways.

Eyde also began writing and performing parodies to popular songs and reworked them to focus on same-sex relationships. At the local bars and clubs she frequented, she saw performers make fun of the gay experience. She described feeling frustrated by this and instead wanted to make art that empowered LGBTQ+ women. She created these inclusive parodies then and performed the songs at local California clubs<sup>29</sup>. One of the songs that she sang in an interview with Eric Marcus highlights her understanding of sexual discrimination within the United States but still offers an optimistic view of the future. She sings:

The world cannot dare to deny us. We’ve been here since centuries past. And you can be sure our ranks will endure as long as this old world will last. So here’s to a fairer tomorrow, when we’ll face the world with a smile<sup>30</sup>.

In this verse, she makes it clear that the queer community is long-lasting and that the community is determined to fight for a brighter tomorrow. It is unclear if Eyde intended the double entendre of the word “ranks” in her song, so as to make a reference to military involvement, however for other queer veterans listening, the word would not be lost on them. Yet again, we see Eyde going through any and all avenues to get involved with the queer community in her post-military life. In doing so, she helped create a queer movement within the constraints of the Cold War environment.

Once RKO studios shut down, Eyde was unable to continue making *Vice Versa* due to lack of funds and supplies. However, this did not mark the end of her journey within the politically active queer community. Instead, she joined the Daughters of Bilitis, a civil rights organization for lesbians formed in San Francisco in 1955 to educate queer women and to lobby for queer women’s rights<sup>31</sup>. While working here she was exposed

to *The Ladder*, for which she later ended up writing. In order to hide her identity and protect herself she wanted to take on a fake name. She took on the name Lisa Ben—an anagram for the word “lesbian.”<sup>28</sup> She continued her work in the gay liberation movement far past the 1960s and passed away in 2015, almost six months after the monumental U.S. Supreme Court case that recognized same-sex marriages<sup>30</sup>.

Eyde’s story follows a common trajectory of the time. She didn’t know much about homosexuality prior to her time in the military. In an interview, she even tells a story of some women who asked her if she was gay. She misunderstood the question and responded “I try to be as happy as I can be under the circumstances”<sup>27</sup>. Following her military experience in 1944, once she better understood her sexuality, she began working at RKO and writing Science Fiction that subliminally touched on LGBTQ+ topics. While it is impressive that she was the first to tackle topics in the first lesbian magazine printed in the United States, she also was a military trailblazer that made gay rights a priority in the years following.

## 2.4 Lilli Vincenz and Public Activism

Lilli Vincenz shared a similar trajectory in the years following her Cold War service. Her post-war experience is one of the clearest examples of gay rights activism. Once her roommate outed her to military leadership in 1963 and she was discharged, Vincenz moved towards finding a new community where she could be herself. In an interview with Jack Nichols, Vincenz describes, “After leaving the WAC, I actually felt free to be me and I immediately joined the Mattachine Society of Washington”<sup>27</sup>. The Mattachine Society was the first LGBTQ+ organization of the time, with the core goal to “liberate one of our largest minorities from. . . social persecution”<sup>16</sup>. Vincenz was the first lesbian member<sup>32</sup>.

In turn, the Mattachine Society prioritized queer protection within the military environment. In 1968, Fort Meyer in Virginia and Fort Richie in Maryland were removing queer women from the WAC at rates disproportionate to other bases at the time. The Mattachine Society conducted private seminars for queer WACs to teach them how to protect themselves against military leadership. The organization also printed and handed out pamphlets titled “How to Handle a Federal Investigation” to give to concerned WACs<sup>33</sup>. WACs risked investigation if such pamphlets were found in their possession. To circumvent this, Frank Kameny — another queer veteran — explains that:

The WACs took about 100 of the leaflets back to the WAC barracks, and late that night they literally plastered the barracks with them. The next morning there were leaflets on bulletin

boards, on tables in lounges, etc. Each officer in the WAC company found one of the leaflets on her desk when she walked into the Orderly Room that morning. Thus everyone had a perfectly good excuse for having a leaflet in her possession, and the good news received maximum dissemination<sup>33</sup>.

In this act, Vincenz became one of the first lesbian members of the Mattachine Society to help queer military women to fight the military's heterosexual standards.

Vincenz also joined the Daughters of Bilitis and worked intimately with the local chapter founder, Barbara Gittings<sup>34</sup>. Through the organization, she worked on *The Ladder* anonymously and went on to become the first lesbian woman to be on the cover of a magazine<sup>25</sup>. Through her involvement both with the Daughters of Bilitis and the Mattachine Society, Vincenz contributed to the emerging queer culture following her military service.

Vincenz was also actively involved in public protests at the time. She was the first lesbian woman to picket the White House<sup>35</sup>. On April 17, 1965, she was one of ten individuals who picketed outside the White House fence, and was pictured holding signs stating, "100,000 HOMOSEXUAL SOLDIERS DEMAND REVIEW OF ARMY POLICY" and "Sexual Preference is Irrelevant to EMPLOYMENT"<sup>35</sup>. She also went on to work with Barbara Gittings, Frank Kameny and others to take part in the famous Annual Reminders, annual picketing protests against the United States government's treatment of queer individuals<sup>36</sup>. The year following the Stonewall Riots, in 1970, the Annual Reminder marched from Greenwich Village, where the Stonewall bar was located, to Central Park in what became the first ever New York Pride Parade<sup>37</sup>. Vincenz, in an interview, pointed out that these public demonstrations received a significant amount of publicity because of how bold it was to publicly march and "out" yourself<sup>28</sup>. But that was the goal: "to break down barriers of public and private and bring homosexual identity into public view"<sup>32</sup>.

In the decade to follow, Vincenz hosted what many call "Lilli's Gay Women's Open House" or the "Gay Woman's Alternative"<sup>32</sup>. Vincenz described the Open House as a place to "accommodate the need for gay and bisexual women, as well as those who thought they might be gay, to meet and talk in a protected social setting. From 1971 to 1978 every Wednesday, rain or shine, our house was open to welcome women"<sup>33</sup>. Vincenz seemingly succeeded in such a pursuit. In a guest book for the open house, one woman wrote, "I'll always be grateful to you and the delightful people I've met here. I've never felt any guilt about being gay, but the Open House has helped me get over my paranoia and loneliness. Thanks!"<sup>32</sup>. Another woman wrote "I was scared shitless. Sat out front for ½ hour before I came in. It was

worth the wait! FRIENDS! I feel at home!"<sup>32</sup>. The environment that Vincenz fostered of open queer positivity and female empowerment in these open houses echo what could have been in the military, had it not have been for restrictive policies that condemned queer individuals to secrecy. Vincenz's path of military enlistment to removal, to queer activism, to the creation of these social gatherings is powerful. The military pushed her to become an activist, where she fought both civilian discrimination and military exclusion. She eventually was able to open her living room every weekend to create the open environment that she said she craved during her military enlistment<sup>25</sup>.

Another major facet of Vincenz' career was her decision to get involved in psychology. Vincenz, prior to her service, had received a Bachelor's degree in French and German and a Master's in English. At that point she entered the WAC, serving at the Walter Reed Army Medical Center, where she was able to receive basic medical training. Following her service, she went back to school to get a Master's degree in psychology<sup>37</sup>. Interviewer Jack Nichols asked Vincenz what she wanted to accomplish after leaving the military, to which Vincenz responded that she wanted to "help unmask the lies being told about us, correct the notion of homosexuality as a sickness and present it as it is, a beautiful way to love"<sup>33</sup>. Upon receiving her degree, she conducted research and worked with queer women within the community from an open-minded standpoint. In her interview with Nichols, she explains that "Many of their wounds have been sustained in the pursuit of and validation of who they are and of not wanting to hide their identity or settle for less. I am grateful to be able to help and to witness their empowerment and healing"<sup>33</sup>. Vincenz used her psychology degree to help LGBTQ+ individuals think of their sexuality in a more positive context. By doing so, she combatted the narratives of other psychologists who saw homosexuality to be an illness, many of whom helped formulate military's exclusion policies that she herself was removed for. Thinking back to the words of Dr. Steiner in *The Ladder*—who called for queer women to help create a more inclusive psychological understanding of sexuality—Vincenz was one of those women who answered the call. Vincenz challenged societal understandings of the queer identity in her work as a psychologist. Rather than go by psychology's past processes of undermining a patient's sexuality, she worked to help queer women cope with their identities and gain greater self-acceptance. Vincenz' psychology work in her post-war years helped create research that contradicted the psychology that backed up the homophobic policies that the military subscribed to and validated the LGBTQ+ identity.

## 2.5 Charlotte Coleman and the Creation of a Queer Female Space

While Vincenz opened up a positive, albeit private, community for women through the creation of Lilli's Gay Women's Open House, queer veteran Charlotte Coleman worked to create more public spaces for queer women. She too shared a similar trajectory as other queer women coming out of the military. Coleman joined the Coast Guard during World War II, where she met Sarah Davis, who told her what "gay" meant<sup>38</sup>. She recalls her time in the service, going around town on her days off so that she could "drink beer. . . right near the barracks" but when doing so, she was required to wear her uniform<sup>39</sup>. Such an attire was restrictive because it denied them anonymity when going out, which served as a barrier to forming queer relations outside of the barracks. This catalyzed Coleman's decisions after she left the war. She went on to create The Front Beer and Wine Bar, the first lesbian bar in San Francisco<sup>40</sup>. In doing so, she created a space outside of the military for queer women to meet and form a community.

The bar served a direct political purpose. The Daughters of Bilitis founders, Del Martin and Phyllis Lyon, asked her to use the bar to host various fundraisers for the organization. Coleman agreed<sup>39</sup>. The Front Bar hosted fundraisers until the California Department of Alcoholic Beverage Control came forward with a list of "morals" charges against the bar, causing her to lose her license<sup>40</sup>. This didn't stop her, however, and she continued to open bars over the years; by the time she retired, Coleman managed 14 LGBTQ+ bars and restaurants<sup>40</sup>. Coleman also helped to create the Gay Olympics and Atlas Savings and Loan, the first LGBTQ+ financial organization in the world<sup>40</sup>.

Coleman's determination to make a queer bar scene reflects a pattern found throughout the United States. For example, a case study done by Melissa Ann Gohlke found that military mobilization during World War II served as a catalyst for the creation of gay bars and a greater gay community in San Antonio<sup>40</sup>. Gohlke explains that the May Act, which targeted "the control of prostitution and lewd behaviors around military installations," blocked service members from seeking out areas in San Antonio where queer individuals were rumored to be<sup>40</sup>. This did not prevent service members from seeking out the greater community. In fact, the opposite happened. Gohlke explains that "Queers found niches in San Antonio's downtown where they carved out spaces for communion and forged the tentative bonds of a queer community"<sup>40</sup>. She argues that these spaces are what eventually would become hot spots for LGBTQ+ bars. Allan Bérubé also points to this in *Coming Out Under Fire*, "When they could get away from military bases, they discovered and contributed to the rich gay nightlife"<sup>3</sup>. As such, the formation and

growth of gay bars coming from the World War II era was largely born from the efforts of military personnel.

The military unintentionally encouraged bar culture through their policies to keep service men and women away from the pre-established "lewd" night life locations. As a result, queer individuals within the military sought out their own secret meeting spots to interact with other queer individuals in the area surrounding the military base. In the years that followed, women like Coleman took on the responsibility of making established queer bars for women that not only bolstered the sense of community among queer women, but also served as a resource for queer activist groups like the Daughters of Bilitis.

## 3 CONCLUSION: A TALE OF EXISTENCE AND PERSISTENCE

Queer servicewomen worked to form intentional communities within American society in the years following their military service in the early to mid-to-late-20th century. The communities that formed because of their actions carried the gay liberation movement forward and advanced the rights of queer individuals in America. Queer female veterans did so by taking on different parts of civilian life that were primarily heterosexual. Fictional work, like the *Well of Loneliness* or *Women's Barracks*, united and validated the queer female military community. In the years following their service, queer women laid the groundwork for queer-acceptance through work done in magazines, like *The Ladder* and *Vice-Versa*. Veterans like Lilli Vincenz pushed for sexually inclusive psychologic studies and worked alongside other veterans, like Charlotte Coleman, to redefine heteronormative public and private spaces as queer-positive through Open Houses and the formation of inclusive bars. In doing so, queer servicewomen played a significant role in pushing forward the agenda of the gay liberation movement and forming a cohesive, women-loving-women community.

## 4 FUTURE DIRECTIONS

Dissemination of the stories of these women can pave the road for a more inclusive environment for queer women in the military who still face discrimination, both explicit and implicit. Even with the hard work that queer servicewomen put in, the end of the early Cold War years and the birth of the gay liberation did not end all discriminatory practices towards LGBTQ+ persons in the military. Don't Ask, Don't Tell, a policy that required queer service members to keep their identity hidden if they wanted to serve, lasted until 2011 and, to this day, queer service personnel face discrimination from within the military.<sup>1</sup> Dissemination of the stories of these women can pave the road for a more inclusive

environment for future queer service women. Who is to say how fast this change will come, but in the words of Lilli Vincenz, “there’s always hope”<sup>1</sup>.

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## 6 EDITOR’S NOTES

This article was peer reviewed.

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# Islamic Revivalism and Democracy in Malaysia

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## Abstract

The paper examines democracy and secularism in Malaysia, a state rooted in Islam, and how it has been implemented in a country with a majority Muslim population. It briefly outlines how Islam was brought to the region and how British colonialism was able to implement secularism and democratic practices in such a way that religion was not wholeheartedly erased. Indeed, peaceful decolonization combined with a history of accommodating elites served to promote a newly independent Malaysia, to create a constitutional democracy which declares Islam as the religion of the Federation, and simultaneously religious freedom. Despite the constitution, the United Malays National Organization, UMNO, Malaysia's ruling party for 61 years, managed to cap democracy through a variety of methods, including enraging ethnic tensions and checking electoral competitiveness. Growing public discontent from such actions resulted in Islamic Revivalist movements and increased Islamization at the expense of secular values. UMNO's 2018 electoral loss to the Alliance of Hope party (PH) suggests a new commitment to democracy and reform, which if carried out, will likely result in a return to secular norms with Islamic elements that still maintain religious freedom rights and democratic practices that have, over the last two decades, been called into question.

**Keywords:** Malaysia – democracy – Political Islam – secularism – modernity

## 1 INTRODUCTION

There exists a widespread belief that Islam and democracy cannot coexist, and since modernity is considered a defining aspect of democracy, modernity and Islam are also incompatible. Malaysia has historically functioned as evidence against this notion as it enforces a constitutional democracy with Islam as the religion of the federation. Consequently, it is considered a model by the West that should be emulated by other southern countries. This provokes the question: how have democracy and Islam taken form and interacted in Malaysian politics and society historically and presently, and will they be able to continue to coexist alongside one another in the future?

The relationship between Islam and democracy within Malaysia is a complex one that evolved as a result of a unique and multicultural history. Indeed, Malaysia's ability to integrate religion, secularism, and modernity into a successfully functioning government within a highly pluralist society has resulted from the meeting of three major civilizations (Indian, Chinese, and European) and two colonial systems. Malaysia experienced peaceful decolonization, which, along with a history of accommodating elites, resulted in an in-

dependent state that kept intact many of the democratic processes and ideologies implemented under colonial rule, specifically secularism. Therefore, it is Malaysia's unique history and interactions that have allowed democracy and Islam to function alongside one another. Nonetheless, research into Malaysia's history and politics reveal discrepancies between democratic ideals and actual policy.

Indeed, the relationship between democracy and religion has not been without tension, and these tensions have become increasingly strained with Islam Revivalist movements. The dissatisfaction with the former ruling political party, United Malays National Organization, resulted in them further limiting democracy and appeasing the public by enacting policies and legislation promoting Islam. These actions implicated the semi-democratic and secular state, calling into question non-Muslims and Muslims who advocate for religious freedom's role in society. Oppositional parties, political movements, UMNO's leniency on Islamic legal rulings, and their employment of tactics that limit democracy call into question if such a pluralist, secular society can continue. Therefore, to examine the relationship between Islam and democracy in Malaysia, we must first understand its rich history and interactions

as well as the government and public sphere since the country's independence in 1957. Furthermore, we must investigate the political spheres to discover why we see increased backing for an Islamic State. Through these investigations, we will also gain insight into the reasoning behind the 2018 election, where Alliance of Hope (PH) unseated UMNO as the ruling party. While it is yet to be determined if PH will maintain its campaign promises, which are characteristic of a democracy, the party's peaceful transition into government and its accordance with democratic credentials thus far are hopeful signs that Malaysia will become more democratic. In the short term, Islamic revivalist movements will continue. In the long-term, with the promised reform, accountability, and ousting of the corrupt UMNO and National Front Party (BN) coalition, it is reasonable to assume the call for an Islamic state and society will be minimized as the people's faith in a secular government is restored. Consequently, Malaysia can find a middle-ground where Islam and democracy can co-exist peacefully alongside one another. Although the relationship between Islam and state has not been as harmonious as the West and Malaysia itself would have us believe, the country continues to strive to establish itself as a model where the two can coincide amicably.

## 2 ISLAM COMES TO THE MALAY WORLD

Some think that Islam came to Malaysia via traders and merchants who traveled through the Malay Archipelago and may have inhabited some ports between the 10th and 17th centuries. Others believe that Sufis brought Islam to the region. Another possibility is that indigenous Malay travelers brought the religion back with them from the Middle East. Either way, the arrival of Islam in the pre-colonial Malay world resulted in numerous critical sociological changes, especially in terms of spirituality, intellectual contribution, and the establishment of a new social order grounded in Sharia. Sufis preached to the Malay people, increasing society's overall spirituality and turned them away from mythology to the belief in one God. The intellectual contribution of Islam in the region was paramount, establishing a social order known as KERAJAAN (a fused church with the state). At the heart of KERAJAAN was and is Shariah, which was enacted holistically, socially, legally, and politically. Indeed, Islam changed the whole of the Malay realm, imbuing it with an Islamic worldview<sup>1</sup>.

## 3 BRITISH COLONIALISM

In the late 18th century, the British colonized Malaysia, imposing Western law and traditions on the region. The British realized that for their control to be successful, they not only had to conquer the physical space but also alter the native's thought system to be in line with

that of the British. The most significant transformation enacted was the transition of KERJAAN to Kerajaan, which implores a separation of church and state. British colonial rule managed to create a secular government through the conquest of epistemological space by transforming the bureaucracy, judiciary, and the education system.

Unlike many other colonialist takeovers, Malaysia was non-violent. Britain established itself gradually first through indirect intervention. Slowly but surely, they began infringing on areas within the Malay sultans' domain. First, with the Pangkor Treaty. Enacted in 1784, it gave the British full authority over Malaysia and was signed by the Malay sultans. The treaty stipulated that all areas excluding Islam and custom were now secular matters. Hence, the sultans relinquished their legislative and political control. Also included in the deal was that sultans should provide a residence for a British officer, referred to as "the Resident," and his advice should be called upon regarding all matters excluding religion and adat (custom.) Despite this outlined divide, the British ultimately managed to control and regulate much religious and customary issues because these were under the jurisdiction of local chiefs and rulers who had essentially become British puppets.

Furthermore, the British conducted religious, administrative reform that limited the jurisdiction and independence of Islamic qadis (judges) in comparison to civic judges. All senior judges were appointed by the British Resident General, whose superiors were trained in the British law system. Thus, they referred to English law instead of Shariah law, as was the case before colonialism. During the colonial period, all legislation and policies introduced were derived from British rule. Thus, the British used their influence to limit Sharia to family law and implement the secular system<sup>1</sup>.

## 4 COLONIAL OPPOSITION AND THE RISE OF POLITICAL PARTIES IN MALAYSIA

British colonial rule did not continue without opposition. A nationalist movement was born with Islam as its ideological platform, and there occurred a shift from a western perspective to one with an Islamic focus. In an attempt to maintain power, the British administration proposed the idea of Pan-Malayan Unity. However, the idea insulted Malay nationalists and sultans. In response, the United Malays National Organization (UMNO) was formed in 1946. Malays acted in solidarity and supported the party, including the ulamas who did not believe it put enough emphasis on Islam, to rid themselves of the British and Western imperialism. The Pan-Malayan Islamic Party (PAS) is the other notable party that formed during this period. PAS, established in 1951, originally began as a section within UNMO but detached itself. It advocates for the creation of an

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Islamic State and still exists today as a major political party and one of UMNO's political opponents. UMNO formed a coalition with Indian and Chinese political parties known as the Alliance Party and won Malaysia's first elections. The coalition expanded to include more political parties, and the Alliance Party became the National Front Party (BN). UMNO was the leading political party in Malaysia until 2018 when it lost its majority parliamentary seats<sup>1</sup>.

## 5 POST-COLONIAL MALAYSIA AND SEMI-DEMOCRACY

The Malaysian constitution shaped and conditioned Malaysian Islam. It proclaims that every indigenous Malay person is automatically considered a Muslim. Therefore, religion is also an ethnic identifier. The constitution also declares religious freedom; illustrating the lasting influences of British colonialism in Malay government and policies, specifically when it comes to Sharia. Sharia courts still have jurisdiction but are limited as they were under colonialism. Furthermore, Sharia does not apply to non-Muslims and is confined to family law. Sharia is also considered 'colonial-modern' because it is highly fragmented and decentralized, meaning how it is interpreted and carried out varies locally<sup>1</sup>.

Since its independence, Malaysia has been considered a semi-democracy and considered as a model by the western democratic world to be emulated by other South Asian countries. The state has also been praised for its ability to have democratic processes, and Islamic values coexist alongside one another. Arguably, the most exciting feature of Malaysian democracy has been its societal pluralism. The British took advantage of the societal pluralism and used it as part of their divide and rule strategy. They gave the Malay aristocrats positions in office and kept Malay peasants primarily confined to agriculture, actively clogging social mobility. Under these conditions, foreign Chinese were able to take hold of the national economy through entrepreneurial ventures. This dynamic created pluralist tensions, but instead of resulting in conflict, they began the tradition of accommodating elites, characterized by democratic attributes such as consultation and representativeness. Malaysia's peaceful decolonization combined with this tradition in accommodation resulted in regime stability, allowing some democratic practices based on procedure (polyarchy) to occupy a space where the majority of the population is Muslim<sup>2</sup>.

The UMNO has interwoven aspects of hard and soft democracy, forming a semi-democracy. Therefore, it has been able to undermine democratic ideals and procedures while maintaining just enough democratic symptoms to be still viewed as a democracy, at least from an outside perspective. Electoral systems at the state

and federal level have been democratic and deemed to be fair. Furthermore, political parties have been permitted to elect their officers. However, they have been methodically prevented from gaining the majority seats in parliament. Additionally, electoral competitiveness has been checked through a series of methods, such as gerrymandering, permitting UMNO to maintain its power. This semi-democracy has allowed for individual freedoms and expressions, though, serving to keep the people and the opposition appeased enough not to protest UMNO's schemes. For example, political parties are free to meet and organize and express dissent and sometimes do gain seats in parliament<sup>2</sup>.

As aforementioned, Malaysia is a highly pluralist society comprised of many ethnic communities that benefit unevenly from economic growth. "However, it is not societal pluralism that in itself weakens the viability of democracy, but instead, the willingness of the elites to exacerbate and exploit it"<sup>2</sup>. The UMNO used the economic disparity between ethnicities to sustain its power in the 1969 elections, triggering ethnic riots. From these actions, the UMNO gained more control in its coalition and established the New Economic Policy (NEP), which aimed to strengthen the Malay middle-class, acquiring on its behalf Chinese companies. It should be noted that while the NEP initially intensified ethnic resentments, it did encourage collaboration between Malay and Chinese businesses and promoted Chinese education and culture. And while ethnic sentiments in urban areas eased due to NEP, they intensified in rural areas as the economic benefits did not extend as drastically in the periphery. During this period, the UMNO used limited democracy as a tool to bend market-behavior to its will while simultaneously laying the groundwork for re-democratization by broadening the middle-class along ethnic lines<sup>2</sup>.

In 1987, the UMNO finally faced a threatening opponent when the party itself split into UMNO (Baru), headed by the Prime Minister Mahathir, and Semangat '46 led by the former finance minister, Razaleigh. Razaleigh appealed to the middle-class, calling for more democracy, and assuring if he were elected a two-party system would be installed, the government would be held accountable and an independent judiciary system that would rid the country of policies promoting favoritism and patronage. UMNO (Baru) did manage to win the 1987 presidential elections at the party's general assembly, but Razaleigh's supporters tried to invalidate the election through media and judiciary efforts. Mahathir responded by closing down certain newspapers and jailing some supporters. The significance of these actions is paramount as it demonstrated UMNO's willingness to limit freedoms guaranteed by democracy to retain its power. That being said, these events also resulted in increasing factionalism within the government. Hence, the period leading up to the 1990 election

was defined by greater electoral competitiveness<sup>2</sup>.

Socioeconomic policies, along with favorable attitudes by the elites, enabled re-democratization during the 1988-90 period. Prime Minister Mahathir allowed Semangat '46 to register as a party to compete in the 1990 election along with other political parties such as PAS and the Democratic Action Party (DAP). These parties were not allowed in the mainstream media but were admitted to travel the country and give speeches, demonstrating democratic openness. However, despite this demonstration, Mahathir's commitments to democracy were questioned when debating if he would accept electoral defeat. However, Mahathir's dedication went untested in the 1990 elections as he and his party were victorious, and the vote was deemed to be fair<sup>2</sup>.

Indeed, after examining the 1990 election, many justifiably assumed that Malaysia was on its way to becoming more democratic with a more competitive party system. Further increasing the expectation for democracy were the other countries democratizing toward the end of the 20th century after the disintegration of the communist bloc. Unfortunately, the UMNO's actions during 1991-92 dispelled this notion because its 1990 electoral victory was too close for comfort. It began using state-owned media as a tool to implicate and demonize oppositional party leaders and censored them in the press, effectively preventing them from expressing and distributing their opinions. Furthermore, UMNO penalized other parties' family members and their businesses. During Mahathir's time as Prime Minister, he continued to justify his actions to remain in power<sup>2</sup>.

To summarize, during the post-colonial period, there have been many reasons for thinking that Malaysia would transition from a semi-democracy into a more comprehensive one. These include "an enlarged middle class, improved ethnic relations, a facilitative international milieu, and an apparent elite willingness to act favorably on these conditions"<sup>2</sup>. However, UMNO's actions, especially during the 1991-92 period, dispelled these notions and instead confined and limited Malaysian democracy, only implementing varying degrees at their discretion<sup>2</sup>.

## 6 THE RISE OF ISLAM IN MALAYSIA

Malaysia is an anomaly because Islam and secularism have managed to coexist within its borders since its independence. However, the relationship has proven difficult to balance as the question remains: what is the supreme law of the land<sup>3</sup>? Indeed, evidence suggests that towards the end of the 20th century, the balance has shifted in favor of Islam.

The 1970s and 80s marked a revived interest in religion. Islamization efforts characterized the decade. These efforts did result in an increase in Malay-Muslim militant activities, but because they were non-violent,

Malaysian Islam has been labeled moderate. The Islamic Revival movement of the 70s and 80s led to Islamization on the structural and societal levels, and Malaysian Islam was able to reestablish itself, intermixing with the plural, the secular, and the modern.

The last three UMNO prime ministers, Mahathir, Badawi, and Najib proclaimed that Malaysia was already an Islamic State, although it can be argued they did so only to compete with the oppositional party, PAS, who had gained a significant following for their advocacy of an Islamic state. It is also speculated that they made these claims to defend their policies, proclaiming their Islamic nature, repeatedly referring to Article 3, which declares that Islam is the religion of the Federation. This endorsement and attempt to assert that policy is rooted in Islam acts as evidence that secular laws are viewed as contradictory to Islamic ones by a significant portion of the Malay-Muslim population<sup>3</sup>.

The Malaysian pluralist legal system is made up of High Courts, which are non-religious, and a network of Sharia courts which are limited to family law of Muslims. The High Courts have unlimited jurisdiction, and the Shariah courts operate within that jurisdiction, meaning they can intervene and overrule decisions made in the religious court. This has created a hierarchical relationship between the two. In 1998, this hierarchy was blurred with the new article 121(1A), which reaffirmed that the civil and religious courts act independently of one another. However, this sparked controversy because of multiple overlapping areas. One especially significant of these overlapping areas is the issue of religious freedom and apostasy<sup>4</sup>.

Article 3(1) asserts that Islam is the religion of the Federation. Until recently, it was agreed upon that this article was not meant to establish an Islamic state, but merely for symbolic purposes and to honor the country's history. Recently, there has been resistance to the constitution and calls to shift from prioritizing the state to prioritizing Islam. The argument being that the state has no right to legislate upon Islamic laws. Increasingly, the High Courts have ruled in favor of Sharia court decisions when cases have been appealed to them. Through these cases, we can see article 121(1A) come into conflict with section 11(1), which asserts religious freedom — for example, the case of Lina Joy. Joy was raised by Malay-Muslim parents and is ethnically Malay and, therefore, by default Muslim. She converted to Catholicism and was engaged to a Catholic man. However, because she was Muslim in the eyes of Malaysian law, she could not marry her fiancé unless he converted to Islam. Joy sought the recognition of her conversion and took the case to the supposedly secular High Court. When the High Court refused to acknowledge her transformation, she took her case to the Court of Appeal and finally, the Federal Court, who also rejected her application. These actions reveal a restrictive interpretation of

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religious freedom at both the spiritual and the federal courts, illustrating a growing Islamization of society and the judicial system. What we are witnessing is a movement calling for a reversal of priorities, favoring Islamic norms over secular ones, and the increasing ability of Islamic laws to regulate secular ones, placing the rights and freedoms of non-Malay-Muslims in a precarious state<sup>4</sup>.

In 2006, Malaysian politics were thrown into chaos not only because of the highly divisive and contested elections (which are characteristic of Malaysian elections since the 90s) but because of confrontations concerning religion's role in the country. Over the last two decades, there has formed a growing division between the Malays who think that Islam should be more integrated into the public sphere and the Malays who believe the two should remain separate. On May 14, 2006, an Article 11 forum was held in Penang, hosted by a group of human rights and advocacy groups to promote awareness of religious freedom rights. The conference was rapidly shut down due to protesting by conservative Muslim groups, including PAS and FORKAD. Both groups believed their position in Malaysian society was being threatened by the other<sup>3</sup>. Enforcing Article 11 is seen by many as a threat to Islamic revivalism. Fearing another incident like the race riots in 1969 and sensing the "growing discontent of the reactionary Muslim groups," the Prime Minister Badawi ceased these "constitutional discussions"<sup>2</sup>.

## 7 2018 ELECTIONS: A NEW RULING PARTY AND WHAT IT MEANS FOR MALAYSIA

The true indicator of a democracy is a peaceful transition of power to a newly elected party. Mahathir, the former prime minister of UMNO and the current leader of PH, ran against UMNO's current prime minister Najib Razak. On May 9, 2018, Malaysia underwent a transformative election wherein UMNO, the ruling political party since Malaysia gained its independence in 1957, and the National Front Party (BN) were unseated by the new opposition party Alliance of Hope (PH). However, whether or not this election will reframe Malaysian society is yet to be determined. UMNO and the BN's fall from grace can be attributed to five factors including corruption, government officials' personal enrichment, "stagnation in quality of living and unpopular economic policies"<sup>5</sup>, UMNO's use of repression and buying support, and social media's role in drawing attention to issues and serving as a platform for discussion and debate<sup>5</sup>.

The UMNO and the National Front Party have been accused of buying support, and many have speculated that they owe their previous electoral victories to nepotism. Furthermore, through money politics (promises, payoffs, resource rents, etc.) UMNO has been

able to spend more on elections and campaigning than any of its opposition. Repression of democracy, laws, and media have also provided the resistance with significant obstacles in gaining support and influence. Explored in previous sections, the UMNO was able to hold its position for so long by arresting opposition members, limiting their activities and resources, and controlling the information in the media. Most significantly, the electoral process itself was rigged through tactics such as gerrymandering and not giving postal voters enough time to send in their votes. The violations of the electoral process did not go unnoticed on the national or international level and significantly contributed to BN's weakening legitimacy. In 2018, Malaysia ranked 142nd out of the 158 countries featured in the Electoral Integrity Project's Global Perceptions of Electoral Integrity (PEI). Malaysia's remarkably low ranking made it impossible for BN to convince the country that proper electoral procedures had been followed<sup>5</sup>.

Corruption has existed within the bureaucracy for years, and Mahathir had his fair share of scandals during his tenure. However, Najib's scandals were more widespread, and there existed increased awareness and concern regarding said corruption. There was a common perception that UMNO bureaucrats were enriching themselves while abandoning their constituents who were facing growing inequalities, thus provoking them. The 1MDB scandal shone a light on corruption in UMNO and played a significant role in Najib's undoing. The population suspected party leaders of illegally lining their own pockets with state funds, specifically those of Najib and his family's. Social media's role in propagating the scandal should be noted as it relayed to citizens the extent of corruption within the government. Social media is a powerful tool against censorship, of which state-owned media is vulnerable. The scandal also exposed a lack of accountability in the government as UMNO made no investigation efforts. Politicians of opposing parties, such as Mahathir and Anwar, have been very vocal with their criticism regarding the scandal and the lack of investigation. Additionally, there were concerns about foreign money's influence in the country. Najib received funds from Saudi Arabia, leaving people to speculate what Najib did to deserve such a generous donation<sup>5</sup>.

Despite the years of undermining democracy and using immoral and unethical tactics to stay in power, there was little expectation that PH would be able to unseat UMNO and BN. This is because, between 2008 and 2015, notable differences emerged among the member parties of PH, one of them being PAS, and many thought it doubtful that they would be able to work together toward a common goal. However, because elections leading to democratization are dependent on the relative weakness of the ruling party compared to the oppositional parties, one can easily see why PH

was able to overcome its perceived lack of compatibility and overtake the majority votes. The United Malay National Organization and the National Front Party's legitimacy had weakened to the point that not even their past tactics could save them. Now remains the question of whether the new ruling party and Mahathir are genuinely committed to reform. Mahathir contributed to and initiated many un-democratic means, including exploiting ethnic grievances and checking electoral competitiveness, to keep himself and the UMNO in power. Furthermore, both he and Ibrahim Anwar, the current leader of the People's Justice Party (in the PH coalition), contributed to Islamization at the fundamental and agency level. While he and his party have seemingly moved away from a race-based focus, time will only tell if he and his party are different<sup>5</sup>.

Malaysia's reform and possible democracy are also dependent on Mahathir's relationships with the PH coalition's party leaders, which have been marred in the past. In 1982, when Mahathir was Prime Minister, Anwar became Vice President of UMNO. Anwar was popular among other leaders within the party, causing Mahathir to worry about his influence. Throughout Anwar's tenure, he and Mahathir were in constant competition, disagreeing over everything. Eventually, Anwar was fired and arrested under the Internal Security Act. Following his imprisonment, the government launched a destructive PR campaign on his reputation. Various other party leaders in PH were arrested during Mahathir's tenure. Thus, there is an obvious need for trust-building among the heads of the parties and Mahathir if PH is to be successful. Leading up to the elections, there seemed a willingness to cooperate; however, the dynamic among government personnel is questionable<sup>5</sup>.

On May 16, 2019, Anwar gave a speech warning against corruption that is already taking hold of the party, though he did not name specific politicians. He also implored citizens to remind leaders against excessive displays of wealth. In the same speech, Anwar announced that when he takes over as prime minister, he will uphold Islamic principles but "will also show concern and love for our brothers and sisters among non-Muslims... that are loyal to us." The speech suggests a continued allegiance to reform and to fight against corruption and respect Islam while maintaining the rights of religious freedom. However, it could also be a strategy to make the public doubtful of individual government leaders and serve as a reminder to the public and Mahathir, of Mahathir's promise that Anwar would be the next prime minister<sup>6</sup>.

## 8 CONCLUSION

Malaysia's unique history is defined by cultural interactions that combined Islam and British colonialism,

which brought democratic practices and secularism to the region, and allowed ideas considered incompatible to operate within the same space. While Malaysia's ability to implement secularism and democracy among a majority Muslim population has been applauded by the West and used as evidence that Islam and democracy can coexist, closer examination reveals a tumultuous relationship where democratic ideals have been increasingly sacrificed.

As outlined throughout the paper, the United Malays National Organization continued the British tradition of playing on ethnic tensions to divide and distract society as a strategy to maintain its power. Its preference and favoritism of Malays disguised by ethnonationalism as well as allowing for increasing Islamization in public and political spheres enabled UMNO to keep the 2/3 majority in parliament for 61 years. Indeed, the UMNO used identity as a tactic, playing on Malay fears that other races would take away their rights. As a result, there have been increasing calls for Islam on behalf of the Malay-Muslim population. Fearing the Pan-Malaysian Islamic Party gaining support, UMNO gradually conceded to keep the people appeased and to minimize PAS's electoral threat. Thus, under the United Malay National Organization, Malaysia slowly began its conversion from a secular state to an Islamic one.

Mahathir's new party leading up to the election was seen as a reliable alternative for Malays because of its focus on reform, righting the economy and apparent commitment to government accountability. Also, the coalition with multiple parties representing different sections of society suggests that the re-democratization that was thought would happen after the 1990 elections will occur now, characterized by meaningful elections and equal representation for all Malaysian citizens. Whether the Alliance of Hope party will be able to fulfill its promises and if the people's hopeful beliefs will be actualized can only be determined in time and through careful observation of PH's actions<sup>5</sup>. If PH's leaders are genuinely committed to reform and can put behind them past grievances, then it is reasonable to hypothesize a decline in Islamization and a return to secular norms in the political, judicial and social arenas with aspects of Islam that still respect the religious freedom of all guaranteed by the constitution.

## 9 EDITOR'S NOTES

This article was written in Spring 2019. Developments have occurred in the political arena regarding Islam and the ruling party's conduct since then. This article was peer reviewed.

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# Morocco's Informal Economy: The Role of Rotating Savings in Rabat

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## Abstract

This research project is a case study concerned with how the practice of Rotational Savings and Credit Associations (ROSCAs) function within Rabat, Morocco. Research was guided by the following questions: Why is this form of money management utilized? Who is the typical participant in ROSCAs? What sort of purchases are financed through this practice? And what does the changing popularity of ROSCAs mean for future generations? In order to begin answering these questions I collected considerable qualitative data throughout my four-month long stay in the Medina of Rabat during Fall of 2019. I also supplemented this data with secondary research done on ROSCAs throughout the world and discussed topics such as the social economy, impacts of Islam, and Morocco's holistic economy. In this paper's summation I review all the collected sources in order to comment on the value of ROSCAs in communities like Rabat, explore possible interferences with my work, and discuss the need for continued research on the topic.

**Keywords:** social science – sociology – economics – public and social welfare

## 1 INTRODUCTION

Rabat is the capital of Morocco, but when mentioning this country to many people, it is usually not the first city that comes to mind. Instead, most foreigners will only be able to name cities like Casablanca and Marrakech. This is related to the fact that Rabat is not the economic or social capital of the country; it is, however, the administrative capital. It houses in near totality all government buildings, in addition to many banks, non-government organizations (NGOs), and company headquarters alike. Despite the presence of institutions such as the national bank, there persists a centuries old *informal* banking practice known as money pooling or *daart*, in Moroccan Arabic. How does this practice work in the modern world? What does it mean for the future of Morocco's economy? These are the kinds of questions I intend to answer through this research project.

There has been research on the topic of rotational savings and money pools (ROSCAs) all over the world. However, the specificities of its existence in the form of *daart* within Morocco have yet to be investigated. This paper intends to explore *daart* through multiple lenses, such as utilitarianism, social economics, and religion in order to give a broad overview of a niche subject. These lenses are guided by several hypotheses. First, that rotating savings has continued to persist among a

globalizing world in order to supplement or altogether substitute welfare, providing access to the newly privatized necessities facilitated by the neoliberal state of the world. In addition to functioning as a coping mechanism for economic needs, I also predict that *daart* is a form of solidarity among participants, who are utilizing the long-standing practice of gift giving and social economics to bind their communities together.

Research was conducted as a case study of Rabat, specifically focusing on how *daart* exists within modern society and affects those involved with them. Through one-on-one interviews with scholars, youth-aged women, and women currently involved in money pools, information was gleaned about the idiosyncrasies of how this practice works in Rabat today, versus in the past. Ultimately this information was used to make predictions about the future of Morocco's economy.

### 1.1 Defining Key Terms

*Daart*: The Darija word describing a rotational saving and credit association (see ROSCA definition). Possibly derived from the verb "*dara*" meaning to rotate or turn.

*Informal Economy*: A framework for people or institutions to provide financial services, goods, and other

exchanges away from the of the control of the State or other authorities. Typical in market based “formal” economies.

*Neoliberalism*: defined by Ashley Davis-Hamel as “a political-economic philosophy that advocates a laissez-faire approach to development by reducing state intervention and relying on unfettered market forces, following capitalist methods of free trade and market expansion”<sup>1</sup>.

*Rotational Savings and Credit Association*: A group of people who agree to supply a fixed amount of money at designated intervals to a common fund. At each interval, the total fund is received by one member of the group to be paid-back in the future without interest added. How the order of rotation is determined varies but is typically either flexible or fixed and done so through negotiation, creditworthiness, or at random.

*ROSCA versus Microfinance*: According to Hossein “Informal banks are run and owned by the users of the same socio-economic class grouping who participate in alternative finance, whereas microfinance institutions are professionalized and led by educated individuals interested in reforming commercial banks”<sup>2</sup>.

## 2 BACKGROUND AND LITERATURE REVIEW

### 2.1 Rotational Savings and Credit Associations

As mentioned previously, there is some written word on the topic of ROSCAs, from both utilitarian economic, and social economic viewpoints. However, when considering that this is a practice that has existed since “before the naming of the social economy came into being”, there is relatively “little to no mention of this contribution in the literature”<sup>2</sup>. In this already limited field of study, the information available about Morocco specifically is almost non-existent. Despite the lack of specific information, it is integral to understand the concept of ROSCAs holistically before being able to look at research on any individual country.

The vast majority of economic literature is conducted from a utilitarian standpoint. Which, as described by Professor of Sociology Dr. Ait Mansour, is a widespread political doctrine believing that humans only do things when there are benefits to be gained. It is perfectly rational, and all actions are determined after weighing financial consequences and utility<sup>3</sup>. Using this ideology to look at ROSCAs has certain strengths and weaknesses.

Among its strengths is that this viewpoint allows one to look at ROSCAs objectively to see why someone may or may not be involved in one. From a basic utilitarian standpoint, participation in a ROSCA comes down to the point at which it becomes more advantageous to use a ROSCA versus an interest-bearing savings account. To break this down: although on a cellular level each member of the group will pay out and receive the same

amount of money over the cycle’s duration, the turn you hold to receive the lump fund makes a difference. The first person to receive funds is given the most credit and is a net debtor throughout the cycle, during which they pay back their debt. The last member to receive funds is getting no credit at all and is a net creditor throughout the cycle. This exemplifies why ROSCAs are pareto-superior to individual savings accounts for all participants except for the last member to receive the money pot. The last recipient essentially just receives their savings and is no better or worse off than if they had not participated at all. The other members received some amount of credit, allowing them to gain additional utility by lessening the time they had to wait to make a purchase<sup>4</sup>.

These observations about positionality throughout the cycle lend themselves to another interesting idea. Some ROSCAs have fixed rotations that predetermine the order in which the funds are received while others have flexible turns allowing for more on the spot decisions about reciprocity. Theoretically, if positions are predetermined, they should be done so based on the individual’s risk of default. Those who are the least risky would receive the money first, and those who are most risky would receive the money last. By these considerations, one’s advancement in the ROSCA cycle can be compared to an increased credit line on a credit card since there has been trust built over time<sup>4</sup>. For groups with flexible rotations, there is higher risk of default overall since those who lobby hardest to receive the money may be most desperate and subsequently the least likely to repay their debts.

The utilitarian strategy of understanding ROSCAs has many weaknesses since it fails to consider that humans are not perfectly rational and there are multiple external forces that substantially change people’s likelihood of participating in a ROSCA. While opportunity costs and pareto-positionality are important considerations, they employ complicated economic jargon and do not reflect the lived experience of the majority of people who are actual ROSCA members. It also does not give credit to the influence of the social economy and utility gained through altruism, which this research intends to consider more thoroughly.

Past the understanding of ROSCAs’ fundamental economic basis, one finds an understanding of ROSCAs that is more rooted in reality. At this realistic core, is an “African tradition rooted in ancient systems of susus and tontines” that serves to mobilize savings for people in hugely meaningful ways<sup>2</sup>. The practice has differing local names, such as susu, tontines, partner, meeting-turn, box-hand, sol, and, in the case of Morocco, is called *daart*. Existing research on the topic focuses largely on the practice as it exists and has existed in Africa and spread to other places such as the Caribbean or even Canada through slavery and the African diaspora. Hos-

## Morocco's Informal Economy

sein's research on this topic has been instrumental to my understanding and has shown that "Pooled banking systems are embedded in social relationships, and business is there to support people's social lives" just as much as their immediate monetary needs<sup>5</sup>.

The way that ROSCAs work in Morocco has the possibility of standing apart from the current subject pool based in other areas of Africa and their evolutionary iterations for several reasons. Morocco exists at the intersection of continents, races, and religions which has made it into country full citizens with of strong transnational identities. While some Moroccans are proud of their African heritage, many people I have interacted with during my time here often don't see themselves as African at all. That is, unless they are commenting on how Morocco is the best place in Africa or the "exception" somehow. Because of this, I believe it is important to conduct individualized research on ROSCAs in Morocco to fill this gap in knowledge and see, to what extent, the current research in other places holds true for Rabat, Morocco.

### 2.2 Morocco's Economy

Morocco has a long and complicated history of wars, dynasties, and foreign occupation, all of which have had important and lasting effects on their economy. Morocco has been classified by the World Bank as a lower middle-income country<sup>6</sup>. Economically, the country has been described as "neither predatory nor developmental", existing in some in-between stage instead<sup>7</sup>. Generally speaking, the country is a relatively data-poor environment. The most recent official information on the informal economy was published by the country's High Commission for Planning in 2014, which makes any sort of data analysis difficult to conduct.

Despite the lack of reliable information about the present economic situation, it is more than possible to look at the country's economic history in order to make inferences about the process of arriving at today's reality. When Morocco gained their independence from France in the 50's, they were still largely dependent on Europe, economically. Without their own secure economic situation, they fell into debt and by 1983 had little option but to accept structural adjustment programs from the World Bank and International Monetary Fund<sup>7</sup>.

These loans were typically "aimed at reducing public debt" in less developed countries, but also had certain stipulations to their access. These stipulations included "far-reaching reforms of existing economic structures", meaning the introduction of neoliberal economics and reduction of barriers to trade.<sup>8</sup> These neoliberal practices, implemented in many countries, has been the catalyst for a trend towards the privatization of many goods and services which were previously public. In ad-

dition to this observation, with two-thirds of Morocco's workforce involved in the informal economy, there is very little protection available for the majority of the citizens in this sector to shield them from economic fluctuations and provide other basic needs<sup>9</sup>.

The younger generations have grown up with these neoliberal practices and capitalism as commonplace. This has created a divide between old and new ways of life across generations as the economy continues to shift away from more traditional values and practices. According to Benieddi, a local writer for Morocco World News, "Children no longer see their parents and traditional values as an example to follow. Parents cannot help their children compete in the new world"<sup>10</sup>. While on paper the "new economy" may be statistically superior to traditional practices, these changes are not necessarily reflecting a higher quality of life since "health insurance and retirement are products that most Moroccans cannot afford"<sup>10</sup>.

### 2.3 Relevance of Protest Movements

As mentioned, the presence of the current neoliberal practices and the relatively unproductive industries that have accompanied them have done very little to help the large population of at-risk, low-income Moroccan citizens. If anything, they have negatively impacted them through the trends of privatization which often times result in higher prices for consumers. These at-risk populations have been increasingly active in the protest scene, demanding more support from the government.

One of the most prevalent and organized protest movements in the country is that of the unemployed graduates. Another largely recognized protest movement is comprised of teacher trainees. Dr. Ait Mansour explained that higher education status in Morocco can sometimes be inversely related to job opportunity<sup>3</sup>. Although during my time in Rabat I have been notified of several large protests, I have only ever encountered one of them, my daily routine left largely disrupted. Life in the medina is business-as-usual despite the more visible unrest in the remainder of the city and country at large.

However, this is not to say that those who live in the medina are not protesting in their own way. Phenomena such as ROSCAs act as examples of what Scott describes in his book as "weapons of the weak", serving as an indication of resistance from those categorized in the lower class<sup>11</sup>. While they are not active participants in direct forms of protest such as marches, sit-ins, and other actions, they choose their own form of opposition that is rooted in their daily lives. This is similar to the ideology promoted by African American scholars of resistance through "self-reliance and group economics"<sup>5</sup>. *Daart* groups are a form of resistance against the hegemony of modern banking practice and require

recognition and exploration through academic research.

### 3 METHODOLOGY AND STUDY LIMITATIONS

In order to gain a better understanding the nature of ROSCAs in Rabat, I collected qualitative data through multiple interviews with various inhabitants of Rabat. Specifically, I organized four interviews with women of various ages, all of whom I had extensive interactions with during my time in Rabat, focusing on women who are active participants in *daart*. I did, however, interview one non-*daart* participant who is a young adult, to gauge how the practice is changing across generations. In addition to these interviews, I also began my research by conducting interviews with two scholars, Dr. Hicham Ait Mansour and Dr. Taieb Belghazi.

#### 3.1 Research Design

Because I was conducting interviews with two categories of people, scholars and *daart* participants, I generated separate guidelines of questions for each, which are included in this paper's appendix. There is some overlap in the questions for both categories, but questions for scholars focused on the topics of *daart*, collectivism, equality, and protection for those who participate in the informal economy. Their answers would establish a better framework for the rest of my interviews. Conversely, the questions for other participants were centered around their personal experiences with and knowledge about *daart*. Interviewees guided the conversations themselves, and consequently there were small differences in questioning from interviewee to interviewee.

Before each interview I explained to each participant the topic of my research and made it clear that they were by no means obligated to speak with me. All of my participants were proficient in English, so all interviews and explanations were done so in English. Since I am familiar with both French and Arabic, I was able to fill in some gaps in knowledge when participants did not know specific words, however I would not be comfortable conducting an entire interview in either language. I obtained each participant's verbal consent to interview them as well as to audio record our conversation. I did not ask for their consent to include names in the study, so pseudonyms will be used for all participants and all other identifying features will be excluded in order to ensure their confidentiality.

Since all interviews were conducted in Rabat, with Rabat locals, it made sense to classify this research as a case study. I do not want to portray this as an exhaustive study or representative of the entire country. I'm not confident that the sample size of interviews is large enough to even be representative of just Rabat.

However, I posited that it would be better to have a semi-representative case study of Rabat than to try and conduct surveys around the country and have the results be less accurate. It was necessary that I considered my time and resources, which will be discussed further on.

#### 3.2 Ethical Considerations and Positionality

Although my research topic is not inherently sensitive in nature, money habits can be deeply personal, and there are numerous important ethical considerations to mention. The first concerns my relationships with the participants. As previously mentioned, I had relationships with each of them prior to the interviews since all participants were in some way contacted through the institution where I completed my studies. In order to try and maintain professionalism and ensure there were no conflicts of interest, I was thorough in explaining to participants that they were not obligated to speak with me. I also explained that the information they decided to share would be used for research purposes, but their identities would be kept anonymous.

Also worth addressing is my personal positionality throughout this research. I am a white, American, upper-middle class student who is incredibly privileged to be able to come into Rabat for several months to study and research. These characteristics not only affected the way my interviewees interacted with me and decided which information to share, but also in my own understanding and interpretation of the data I collected. My lack of ability to communicate fully in Arabic also changed the way I was able to conduct my research as well as limited the information I was able to read on my topic ahead of time.

Since I had relationships with all my participants prior to interviews, this affected the pool of people I had access to in terms of their socioeconomic status. All participants, excluding one student, were employed in full-time positions in jobs included in the formal economy. This has significant implications for findings, seeing as a large number of *daart* participants are not employed in these sectors and may have differing experiences as a result.

Lastly, it is worth noting that my research took up only four weeks of what was already a very brief stay in Rabat. This ultimately limited the scope of what was practical to complete. Time and resources were not available to conduct a study that is fully representative of my topic. There are undoubtedly more considerations that could have changed the research findings, such as the fact that all interviewees were women, but those reviewed in this section were of the greatest concern.

#### 4 FINDINGS: THE FUNCTION OF ROSCAS IN RABAT

In order to give an overview of how *daart* is used as a practice in Rabat, a broad overview will be given first. This will be followed by a comprehensive overview of all interviews, with the discussions broken up into the three subtopics of Islam, capitalism and neoliberalism, and the social economy. Since the phenomena of ROSCAs was unfamiliar to me prior to beginning research, the original assumptions and hypotheses were challenged and disputed in surprising ways throughout the interviews with *daart* participants.

Demographics were a deeply interesting topic that, admittedly, did not get explored deeply in this research. However, the qualitative information collected reflects that, while the majority of *daart* participants are women, it is not unusual for men to also be involved in these groups. Age fluctuates across participants, but generally begins after the completion of school and includes people of all ages who have some sort of income.

Prior to conducting interviews, there was a hypothesis that participation in *daart* was determined on a binary basis. Either Moroccans were forced to join ROSCAs because of exclusion from and restrictions of modern banking, or they participated in them for purely social reasons. The research indicates that this binary nature holds true to some extent. However, not all Moroccans who participate in *daart* fall into the same category. The reality is a more complex, combined version of the original hypothesis. Usually, there is one person who needs a large sum of money for a purchase. This person becomes the organizer of the ROSCA, and contacts their friends and coworkers to ask if they would be willing to join in the *daart*. This organizer falls into one category, but it is often the majority of members who belong to a second category. The second group is made up of those who do not necessarily *need* to participate but do so in solidarity with their friends and acquaintances who need help. In addition to these factors, altruism and cultural norms are also important considerations that will be explored further.

The descriptions of *daart* groups varied across interviews, but there were general trends. For example, participants spoke of older women who did *daart* with as little as 20 dirham (Moroccan currency). For one participant, 1,000 dirham was the most she had ever utilized, while for another 1,000 dirham was the average amount of her groups. These differences reflect differences in age, income, and the needs of the rest of the group. Another factor that varied, to a lesser degree, is the number of members in each *daart* group. Interviewees expressed their desire to keep the group small in order to lessen the waiting time for their turn, as well as for general ease. As a general rule, the groups were made up of more than 4 but less than 10 people each.

Participants described all sorts of different things that the sums of money were typically spent on. The hypothesis that money was spent as a substitute for public services and expenses, such as healthcare, did not hold true in the interviews. One participant, Maha, described that, in her experience, “they want to have it around the time of the sacrifice to have enough money for *eid al kebir*, or for school for children, or to have it at the time of vacation end of august or July”<sup>12</sup>. Fatima, another participant, shared that she spends the money she receives in her turn on rent and sports equipment<sup>13</sup>. It appears that the majority of *daart* participants choose to spend money on entertainment and more luxury items and experiences rather than on absolute necessities.

Outside of these general descriptions of *daart* as a practice in Rabat, three major themes revealed themselves during preliminary research and interviews. These themes were religion, capitalism, and anti-utilitarianism. Each theme was thoroughly explored through research. The following is a breakdown of findings within these three themes.

##### 4.1 In Relation to Islam

The majority of Morocco's population identifies as Muslim, and the King of the country holds the title of “commander of the faithful”. Islam plays a large part in discussing Morocco as a country, but it also affects the lives of average Moroccans in smaller, but largely impactful, ways. Exploring the relationship between the popularity of practicing *daart* in Morocco and the presence of Islam was done so through interviews by asking about the concept of *zakat*, which is the pillar of Islam related to almsgiving and facilitating the flow of wealth from wealthy to poor. This served as a good entry point to conversation about Islam since it did not involve directly asking about the religion of the interviewees or their personal financial status. It turned out that most research participants brought up their religion or Islam in our discussions before I even had the opportunity to ask about it. This confirmed that Islam is central to many different aspects of life in Morocco, including financially, through ROSCAs.

In Islam, there is a concept called “*riba*”, meaning usury, which is forbidden in the Quran and classified as *haram*. In the Quranic verse 3:30 (Translated by Muhammad M. Pickthall) it is stated “O ye who believe! Devour not usury, doubling and quadrupling (the sum lent). Observe your duty to Allah, that ye may be successful.” This is one of multiple verses that discourages charging interest. Because of this, many Muslims will not use modern banking, and *daart* presents itself as a natural alternative, since the absence of interest is a fundamental aspect of ROSCAs. It is also notable that, according to Hossein, “many Muslims do not charge a ‘service fee’” to participate in ROSCAs “whereas a

number of Caribbean groups in a partner bank require a fee of twenty dollars to go to the person managing the fund<sup>5</sup> for what I assume are similar reasons related to *riba*<sup>5</sup>. This characteristic of interest being *haram* has also led to the modern phenomena of “Islamic banks” in Morocco, which several participants mentioned in their interviews. According to Dr. Belghazi, the “rationale for this Islamic banking is banking which does not operate with the logic of banks, where you have profit and so on. They present themselves as adhering to a logic that is not mercantile”<sup>14</sup>. Customers come to the Islamic banks and describe what it is they would like to borrow money for, typically large purchases such as cars or homes. The Islamic bank proceeds to purchase that asset for the customer, who then pays back to the bank the price seemingly without any interest over time. However, these Islamic banks have a reputation for increasing the incremental payments in order to make up for this “interest-free loan”. The final payment sum amounts to greater than the interest that would have been paid on a loan from a modern bank. Those who spoke about Islamic banks in interviews shared the sentiment that the name is largely a marketing tactic, but that other people did utilize them regardless, justifying that it is “*bayeh aw shirah*”, or pay and sell.

Despite loans from banks being *haram*, numerous Moroccans choose to take them out. According to Maha, who has participated in *daart* for almost 30 years, taking loans from the bank is sometimes necessary, and should not be punished because:

“It’s economic thing, it’s not in the past, maybe in the time of the Prophet or the first time of Islam it was maybe not Muslim people who want- who can borrow the money to the people and they want them to return it double or triple, this I can understand. Here it’s helping with, it’s like they are working for us... I don’t know, it’s not I don’t think about Islamic thing, it’s an economic thing. Here it’s helping with, it’s like they are working for us... and everyone did it”<sup>12</sup>.

In order to make large purchases, Moroccans must either go to the bank and receive a loan, going against their personal beliefs, or go without that purchase. Fatima, a woman in her 30s described this, saying:

“I think especially in the big cities people take the loan from the bank because they don’t have any choice. And some of them who take the loan are, you know, they told me it’s like a war between them and the bank and Allah. Because the money at the end of each month, they don’t find any money with them, all disappears”<sup>13</sup>.

These two observations begin to indicate the complexities of how Islam is involved in *daart*, as well as peoples finances overall.

The original hypothesis that Moroccans use *daart* to replace state welfare due to the exclusion from modern banks was challenged and disputed in interviews. In fact, almost the opposite holds true. Although participants described difficulty getting loans without proper paperwork and proof of income. Instead of being forced into using *daart*, the reality is that *daart* is not able to fully finance most large purchases that people would be seeking loans for in the first place. Subsequently, Moroccans have little choice but to accept loan terms from the bank, although it is not their preference. Islam also had important implications in relation to the social economy, which will be discussed in the next thematic section.

#### 4.2 Collectivism and the Social Economy

At the beginning of research, it was unclear if the relationship between community and ROSCAs was a chicken or egg scenario. Meaning, if the community facilitated the *daart* group or if the presence of the *daart* group created a community. Through interviews, trust was a topic that came up repeatedly, which led to the seemingly obvious discovery that most people are not willing to give their money to a complete stranger. This turned out to be a driving force behind how participants decided how and when to participate in *daart*.

As previously described, the formation of a *daart* group often begins with one person who is in need of money the most urgently. This person will then contact friends, family, and acquaintances asking them if they will join the group, telling them how much money would be paid each turn and how many participants would be involved. In interviews with Maha and Aicha, both women stated that although they were not the one in need of the *daart* group, they would participate regardless in order to help whoever is in need, especially since it is not outright charity<sup>12</sup>. People see *daart* as a way to help others and be social, but with the caveat that they will be getting their money back at some point, creating the distinction between *zakat* or charity, and *sehlef* or borrowing. As Maha describes it, “I can say that it is a social, we support each other, it’s like a social group, to help them without giving them this money and you will not have it”<sup>12</sup>.

This social aspect of collectivism and helping one another is a deeply rooted cultural feature of Morocco. Dr. Belghazi mentions this, describing that in the colonial period and before, a concept called *twiza* was present in Morocco. *Twiza* was the practice of helping one another, and was especially common among those in the countryside<sup>14</sup>. The presence of both *twiza* and the social economy in Morocco are consistent with Marcel

Mauss' writings on "The Gift" in primitive societies<sup>15</sup>. In this social economy, the act of participation in giving and receiving from one another makes strong alliances and communities between people.<sup>15</sup> This becomes a sort of positive feedback loop where the strong communities built through giving to one another encourages citizens to feel comfortable enough to ask for help, such as through *daart*. So, while there is a certain amount of utility gained from altruism of helping a peer, there is also a human connection and societal expectation completely separate from this altruism which perpetuates the occurrence of phenomena like *daart*.

While this strong sense of community and willingness to ask for help are inherently good things, there are also important concessions to be made on this topic. As explained by Gibson-Graham, community does not mean homogeneity, and in a community such as the medina of Rabat, not all people have the same experience<sup>16</sup>. Also, it is important to avoid positioning the community economy "as 'other' to the so-called 'real economy'" since both forms of conducting business are just as real and impactful as one another<sup>16</sup>.

Another important caveat is the differing opinion from a youth perspective. In speaking with Roquia, a college student, it became clear that not all Rabat residents see *daart* as practical or recognize the more social aspects of participating. Roquia described how she did not think she would ever do *daart* in the future since, to her, it is the same thing as just saving her own money<sup>17</sup>. However, in other interviews, participants noted that they did not become aware of or join a *daart* prior to finishing school or obtaining a job with an income, and Roquia's view could be another representation of this.

Trust and the desire to help others were central aspects of all interviews surrounding the catalyst for joining a *daart* group. This reflects the strong social economy present in Rabat and the residual gift economy still present in an otherwise modernizing city. Instead of doing *daart* for utilitarian purposes of strictly benefitting financially, participants were much more concerned with the well-being of their peers and perpetuating a collectivist culture.

### 4.3 As a Response to Neoliberalism and Capitalism

In an increasingly globalized world, Rabat is not untouched by the presence of capitalism and other neoliberal practices. Multinational companies such as Carrefour have multiple locations in the city, and there are tourists in the streets each day. ROSCAs however, are not a post-capitalist system of economics but a pre-capitalist one, to some extent. This makes for a very interesting contrast in the lives of Moroccan citizens, as traditional and modern methods of business come face to face.

According to Gibson-Graham, "the qualities associated with economic transactions mediated by the (capitalist) market" are that it is "anti-political, asocial, individual, dis-embedded, rational, efficient, short-term, calculable, incontestable", etc<sup>16</sup>. All these qualities stand in stark contrast with the qualities just laid out in the social economy perpetuated through *daart* and ROSCAs. This is because practices like *daart* "are collective in nature and they are not driven by profit" unlike the development-centric nature of neoliberalism and capitalism<sup>2</sup>.

Using *daart* and ROSCAs as an alternative to more widespread capitalistic systems of conducting business goes back to ROSCAs as a weapon of the weak. Although participants may not see their own actions in this light, it is a challenge to hegemony, nonetheless. As stated by Hossein, "The ways in which persons of African descent organize in the social economy is vital to unravelling the market fundamentalist view that there is only one way to do business in society"<sup>5</sup>. This is an important stance to take in a place where neoliberalism's hooks are less culturally vital, in contrast to countries such as the United States.

Some Moroccans do favor these ideologies to the collective and social nature of the majority. In conversation with Maha, she described this by making an example of her cousin who is an economist, saying that, "In economics, *daart* isn't something that they study there. So they say 'okay it doesn't exist. We cannot help each other with this'"<sup>12</sup>. In this same category is Roquia, who posited that she would rather keep her money to herself for the fear that it would not be repaid by the other members of the ROSCA<sup>17</sup>.

Although the interview participants did not directly address capitalism by name in their interviews, it was a relevant topic in other ways. For example, part of Fatima's justification for using *daart* is that that using modern banks and accepting loans makes her less "free" to do as she pleases<sup>13</sup>. The preference of utilizing alternatives to modern banking is a welcome reminder that there is more than one way to do business, and that challenging the norm can be done through small acts of daily resistance.

## 5 CONCLUSION

Coming from a Western standpoint, I had little knowledge of what ROSCAs meant to people or how they were used. Because of this, my preliminary hypotheses were either inaccurate or not asking the right questions. Luckily, the opportunity to do research allowed for further understanding of ROSCAs and those who participate in them. For the most part, people participate in *daart* with those in their communities for a variety of reasons, but not necessarily as a substitute for social welfare. Instead, people are motivated by supporting

those in need, and convenience of *daart* over banking for daily purchases.

As stated, I did not have the time or resources to give a fully comprehensive review of this topic. For continued research on the topic, it would be interesting to do a similar case study between two countries, both with Muslim populations that were previously French colonies. I would analyze how ROSCAs are used differently in each country to determine more contributing and individualized factors of participation and popularity. Also notable is that, since all interviews were conducted with women, it would be more representative of Moroccan *daart* to expand interviews outside of just the female perspective. Despite first impressions, I have come to realize that it is not taboo for men to also participate in *daart* groups. Lastly, future research would benefit from studying differences in participation between the different ethnic groups present in Morocco, as well as across regions of the country.

History is currently at a crossroads of sorts. Are we to continue on our current trajectory and do unrepairable damage to our planet and relationships with one another? Or do we re-connect with our communities and the Earth to change the way we live our lives and conduct our business for the good of the future? Thinking about Moroccan ROSCAs is a part of this questioning about how we live and organize our lives. The story of *daart* is just one example of the impressive nature of ROSCAs all over the world, and their ability to tie individuals together and allow them to command their lives in ways that would not be possible on their own. Perhaps a more collective society on a global scale, where care is taken for the economic and social wellbeing of our peers, could be part of the solution to our disconnect with ourselves and with our communities.

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## 7 EDITOR'S NOTES

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# Linguistic Complexity and the Post-Earnings Announcement Drift

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## Abstract

In this paper, I investigate the relationship between the verbal complexity of annual earnings announcement conference calls and the Post-Earnings Announcement Drift. I determine the degree of linguistic complexity in conference calls of large public companies in the S&P 500 using the Fog Index from computational linguistics. Consistent with my hypotheses, I find that both the timeliness and magnitude of the market's reaction to qualitative information in annual conference calls exhibit evidence of a price drift. This research may be relevant to analysts, investors, managers, and regulators that wish to standardize how information within earnings conference calls is presented.

**Keywords:** linguistic complexity – conference calls – information asymmetry – disclosures

## 1 INTRODUCTION

This study seeks to explore the Post-Earnings Announcement Drift (PEAD) and the managerial factors that influence investors' responses. Specifically, I attempt to gain a better understanding of how the complexity of managements' statements during the annual earnings conference call influence the PEAD. The PEAD is defined as the cumulative "abnormal" return either above or below the expected return of firms for up to 60 days following an earnings announcement<sup>1,2</sup>. It is one of the most perplexing anomalies in accounting research and has been referred to as the "granddaddy of all underreaction events"<sup>3</sup>. The PEAD is a puzzling and persistent topic in accounting literature in part because it has continued for nearly five decades, and new drivers are regularly identified<sup>4</sup>.

To frame the motivations for this research, I invoke *information asymmetry* within accounting research and why disclosures, in this case verbal disclosures, are a significant source of information. In business, information asymmetry occurs when management possesses material information that external users of the financial statements are not privy to therefore creating a "gap" in knowledge<sup>5</sup>. For example, because a manager is involved in the day to day firm operations, they will undoubtedly have a better estimate of true firm performance than any financial statement can provide, but the underlying intent of the accounting information is to reduce this "gap" between parties. Therefore, I rely on

economic theory that suggests informative disclosures reduce the level of information asymmetry between investors and managers resulting in a lower PEAD<sup>6</sup>.

Across all disciplines, information undoubtedly influences decision-making. In accounting research, information is considered to be informative if it can change the beliefs of the receiving audience. In a theoretical world with perfect conditions of a fully efficient market, the timing, amount, and uncertainty of a firm's future cash flows are known by all market participants. Therefore, the expected earnings of the firm would be equal to the actual earnings of the firm. There would be no drifting of prices nor earnings surprises; unfortunately, real-world conditions exhibit significant uncertainty to describe anomalous and inefficient pricing movements. Underpinning the PEAD is the concept that new information changes the beliefs of the market, such as external users of the financial statements like analysts and investors with delay.

Prior accounting literature is replete with driving quantitative factors of the PEAD, but only recently has the influence of *qualitative* information been explored. There is extensive literature describing that investors possess a limited attention to process complex quantitative information<sup>7</sup>. Thus, if investors, as an aggregate, are slow to process complex information due to time necessary to collect, interpret, untangle, and efficiently trade on their information set, it is logical that stock pricing incorporates information with some delay. I argue that some drifting of asset pricing behaves

similarly with *qualitative* information. This assertion coincides with many pioneering studies, including Das and Chen<sup>8</sup>, Tetlock<sup>9</sup>, and Li<sup>10</sup>, which find that managerial word selection and the language used by media to report on firms have been shown to be correlated with future stock returns and earnings<sup>11</sup>. I predict that the timeliness and magnitude of the investor's reaction is correlated with the level of complexity in the earnings conference call.

An annual conference call is composed of two sections, a prepared management discussion of results followed by a question and answer session between management and institutional investors. I use both management's prepared remarks and the question and answer portion of the annual earnings conference call as the primary source of management's communication. By reviewing both sections of the conference call, I may holistically view management's communication. Ideally, the question and answer section of a conference call organically informs external users of financial statements to reduce information asymmetry. Finally, the latter section of the conference call better reflects intentional managerial actions because the language used is live and reactive to investor questioning<sup>6</sup>.

Resulting from my statistical analysis, I find there to be a positive correlation between linguistic complexity exhibited by management on conference calls and the related magnitude of the PEAD and timeliness of information appropriation. At the time of writing, no other research has analyzed the complexity of verbal disclosures in driving the extent of the PEAD. This research may be relevant to analysts, investors, managers, and regulators that wish to standardize how information within earnings conference calls is presented. Furthermore, this research is important to investors because management's verbal communication contains important textual information indicative of future firm performance beyond the financial statements proper. This can help to influence the asymmetric information gap between investors and managers.

Despite cumbersome effort to offset the inherent limitations of any empirical study, this novice analyst notes significant constraints relating primarily to the robustness of statistical analysis. This empirical study is limited to a small yet, still statistically relevant, sample size sourced from manually coded measures of disclosure quality. Future studies may consider leveraging linguistic software to create a stronger statistical analysis. Another major limitation concerns the vast array of information and complexity of market forces that add noise to the information process, making it difficult for researchers to isolate drivers of PEAD. Other determinants, such as quantitative information present in a conference call and during an earnings presentation, general market conditions, historical firm performance, and management characteristics, should be acknowledged

because they are present in investors' assessments of firm value and hence influence the PEAD. Finally, due to the nature of the sample, the results may exhibit some self-selection bias because electing to host a conference call is a voluntary choice. Therefore, regardless of any other firm specific factor, this sample is inherently limited to those companies that have chosen to participate in a conference call.

## 2 HYPOTHESES DEVELOPMENT

As information becomes more complex, there is an increased time to fully process and understand a situation. For an individual, these inferences are based on Information Processing theory rooted in human psychology<sup>12</sup>. For example, if we were driving in a new area attempting to read a road sign, our ability to come to a conclusion as to where we were going would be influenced by the complexity of the situation, such as the color of the sign, the language of the sign, the time of day, the distance from the sign, etc. That is, as the plethora of stimuli surrounding the sign becomes more complex, it takes us longer to understand the message. Despite the number of people in the vehicle, there will still be a slight delay but, processing time will be reduced as the number of people looking at the sign increases.

I apply processing theories to the accounting research setting to examine whether the level of complexity of the conference call drives the timeliness and magnitude of the PEAD. I predict that as disclosures become more (less) informative, there is a reduction (an increase) in the level of information asymmetry between managers and investors as demonstrated by lower (higher) PEAD. My proxy for informativeness is the degree of linguistic complexity displayed by management. These dynamics may be broken down further into two specific hypotheses regarding the impact of complexity on the timeliness and magnitude of the PEAD, respectively.

First, I hypothesize that less information asymmetry between managers and investors will solicit a smaller magnitude, in terms of absolute percentage, of the abnormal return of the related stock price over the expected return. The magnitude can be viewed as being a function of the timeliness of information appropriation as well as the informativeness of the accounting information. Therefore, as market disclosures become more informative, the absolute range of the abnormal return will diminish; there will inherently be a reaction to the earnings announcement and less abnormal drifting of price because investors may arrive at a consensus sooner.

H<sub>1</sub>: The level of linguistic complexity exhibited by management on the conference call is positively associated with the magnitude the PEAD.

Second, I hypothesize that as disclosures become

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more informative, the time delay of information appropriation will be reduced. Therefore, more informative disclosures will still produce a drift due to the inherent processing time needed by investors but, such drift will be shorter in time as compared to obfuscatory<sup>1</sup> comparison disclosures of other firms. As market disclosures become more informative (i.e., less complex), the aggregate investor pool may arrive at a consensus price in a shorter amount of time because there is less extraneous information to process. This is analogous to the prior example of reading road signs.

H<sub>2</sub>: The level of linguistic complexity exhibited by management on the conference call is positively associated with the time delay of information appropriation.

## 3 RESEARCH DESIGN AND SAMPLE

### 3.1 Measuring PEAD

The PEAD is measured as the cumulative abnormal returns from the event day (conference call) to 60 days thereafter. Abnormal returns are calculated based on the three-factor capital asset pricing model<sup>2</sup> of Fama and French<sup>13</sup>.

### 3.2 Measuring Complexity

The degree of complexity embedded in managerial statements is defined as *linguistic complexity* which refers to all aspects of a language that make communication easier or simpler when speaking<sup>14</sup>. To quantify this complexity, I utilize the Gunning's *Fog Index* of Readability Formula to value the comprehensibility demonstrated on each conference call. The *Fog* index has been used in many disciplines and only recently finding an application in business research. Developed in 1952 by Robert Gunning, this index comes from computational linguistics literature and combines the number of words per sentence and the number of syllables per word to create a measure of readability. Therefore, assuming that all else is equal, the more syllables per word or more words per sentence make a qualitative information set harder for the audience to comprehend<sup>10</sup>. The *Fog* index is a function of two variables:

*Fog Index* = 0.4 (average number of words + percentage of complex words)

Moreover, the *Fog* index estimates the number of years of education needed to understand the informa-

<sup>1</sup>*Obfuscation* in accounting research refers to the intentional attempts of management to confuse users of the financial statements.

<sup>2</sup>The three-factor capital asset pricing model (CAPM) calculates the expected returns of a firm as being equal to the risk-free return (typically the yield on 10-Year US Treasury Bonds) plus a risk premium, which is based on the beta (firm specific risk) of that security.

tion on the first reading. Thus, the higher the value, the more complex the text thus in theory requiring more effort to read it. A *Fog* score of 8-10 is considered elementary, 10-12 is ideal, 13-18 is difficult, and any score above 18 is effectively incomprehensible<sup>10</sup>. I capture the *Fog* score separately for both the formal presentation and management's answers to analyst inquires as reflected as the variables of *Fog(Present)* and *Fog(Response)*, respectively, in the analysis section to follow.

### 3.3 Regression Analysis

In order to examine the relationship between linguistic complexity and the PEAD and test my hypotheses, I estimate multivariate regressions<sup>3</sup> to measure an association between the *Fog* complexity metrics and the abnormal return of the firm.

### 3.4 Sample and Descriptive Statistics

The sample period for my study includes years 2015-2018, resulting in data on 200 firm-years among the 50 companies in my sample. I hand-collect conference calls transcripts sourced from a variety of sources including the respective firm's investor relations page or proxy websites containing firm-specific financial information particularly, seekingalpha.com. Stock returns and other accounting items are sourced from Center for Research in Security Prices (CRSP) and Compustat data. A disadvantage of such a small sample size stems from the difficulty in drawing clear and generalizable inferences due to lack of statistical power. The cost to manually source and analyze such data for the purposes of this research has ultimately led to this concession. As a result of the relatively small sample size used in this research, both the *Fog* index and the number of words measurement are inputted manually to a computer program sourced from a website dedicated to the measurements<sup>15</sup>.

Before performing regression analysis, it is important to isolate pertinent variables that control for key differences in firm characteristics. Table 1 presents the variables used in the multivariate regression of this study. As a result of CRSP and Compustat data limitations, observations for which data on all variables are available reduces sample to 150 firm-year observations. *ABRET* is the key independent variable, described as the difference between the expected Capital Asset Pricing Model (CAPM) return of the firm and the actual firm return. *Net Income* is an important variable to control for firm performance in the period of the conference call. *R&D* expense is important to consider because it is a proxy for information asymmetry between managers and external users of the financial statements. Finally,

<sup>3</sup>Regression analysis is a set of statistical processes to estimate the relationship between a dependent variable and one or more independent variables.

**Table 1** Descriptive Statistics of Pertinent Variables. This table presents the descriptive statistics for the variable used in the following regression analysis, with the abnormal return (*ABRET*) as the independent variable. The dependent variables are the measures of linguistic complexity (*Fog(Response)*, *Fog(Presentation)*) and the variables used to control the primary other determinants of abnormal return as annual performance, information asymmetry, and size, as *Net Income*, Research and Development (*R&D*), and the logarithm of total firm assets (*Log(Total Assets)*), respectively.

Variable	N	Mean	Std. Dev.	Sum	Minimum	Maximum
ABRET	150	0.0042	0.0355	0.6365	-0.1031	0.1503
Fog(Response)	150	11.5308	1.4042	1730.0000	8.3740	15.9700
Fog(Presentation)	150	13.1852	1.2719	1978.0000	9.1840	15.8000
Net Income	150	0.0975	0.0721	14.6171	-0.0367	0.4377
R&D	150	0.0506	0.0600	7.5933	0.0000	0.2915
Log(Total Assets)	150	10.9276	0.9956	1639.0000	8.3109	13.1076

**Table 2** Pearson Correlation Coefficients, N=150. This table shows the Pearson correlation coefficients of abnormal return (*ABRET*) with the measures of linguistic complexity (*Fog(Response)* and *Fog(Presentation)*) and the variables used to control the primary other determinants of abnormal return as annual performance, information asymmetry, and size, as *Net Income*, Research and Development (*R&D*), and the logarithm of total firm assets (*Log(Total Assets)*), respectively. \*\*\*, \*\*, and \* denote statistical significance at the .01, .05, and .10 rounded levels, respectively.

	Fog (Response)	Fog (Presentation)	Net Income	R&D	Log (Total Assets)
ABRET	0.16492***	-0.00428	0.05575**	0.01561*	-0.05636
Fog(Response)		0.18320***	0.00691	0.11431***	-0.18379
Fog(Presentation)			0.05982**	-0.00332	0.11819***
Net Income				0.05422**	-0.34287
R&D					-0.28173

although accounting for the *Total Assets* of these firms adjusts for size, taking the logarithm further controls for potential skewness in firm size in the sample population.

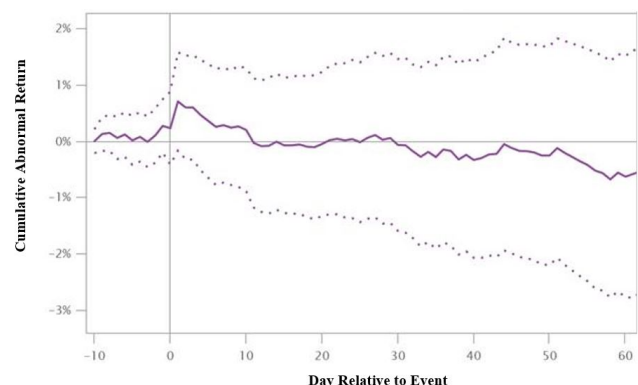
Table 2 presents the Pearson Correlation Matrix of the pertinent variables identified in Table 1. I note a minor correlation between *Net Income* and *ABRET* of .05575 and a significant correlation coefficient between the abnormal return (*ABRET*) and the *Fog(Response)* of .16492. Before any substantial analysis, this correlation initially indicates that there may be a statistically significant relationship between the abnormal return and the complexity of management's responses. Furthermore, this is a strong correlation in comparison to the other variables that are either negatively or insignificantly correlated to the abnormal return. Additionally, there is a strong correlation between the *Fog(Presentation)* and the *Fog(Response)* of .1832. This is an understandable relationship because as a firm's operations increased in complexity, so too would the language needed to transmit the necessary information to investors in both formal presentation and responses to questions.

#### 4 RESULTS

As a baseline test to identify a market reaction to conference call data, I graphed the cumulative abnormal

returns, on the x-axis, against a number of days before and after the call, on the y-axis. This graph represents the PEAD, and the data is similar to graphical representations in seminal papers on earnings drifts<sup>2</sup>.

Abnormal returns are defined in this study as the amount above or below the expected Capital Asset Pricing Model (CAPM) market return. The *Day Relative to Event* is the number of days before and after a call, from 5 days before to 60 days after.



**Figure 1.** Cumulative Abnormal Return. Figure 1 presents the initial cumulative abnormal compared to the expected return, expected as a result of the Capital Asset Pricing Model (CAPM)<sup>4</sup>. The solid line represents the average abnormal return while the dashed lines represent the minimum and maximum abnormal returns.

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**Table 3** Preliminary Regression Outputs. Table 3 presents the regression outputs of a simple relationship between the measures of linguistic complexity *Fog(Response)* and *Fog(Presentation)* and abnormal return (*ABRET*) before controlling for specific firm factors.  $R^2$  and Adjusted  $R^2$  present how well the regression measures the relationship between the sample data and the variables isolated. \*\*\*, \*\*, and \* denote statistical significance at the .01, .05, and .10 rounded levels (two-tail), respectively.

Variable	Coefficients	Standard Error	t-Stat	P-value	Heteroscedasticity Consistent		
					Standard Error	t-Stat	P-Value
Intercept	-0.0326	0.0353	-0.92	0.3574	0.0332	-1.00	0.328
Fog(Response)	0.0043**	0.0021	2.07	0.0399	0.0018	2.45	0.016
Fog(Present)	-0.0010	0.0023	-0.43	0.6667	0.0021	-0.50	0.631
			$R^2$	0.0284			
			Adjusted $R^2$	0.0152			
			Observations	150			

**Table 4** Multivariate Regression Outputs. Table 4 presents the outputs of a multivariate regression between the abnormal return (*ABRET*) and the measures of linguistic complexity *Fog(Response)* and *Fog(Presentation)*, and the variables used to control the primary other determinants of abnormal return as annual performance, information asymmetry, and size, as *Net Income*, *Research and Development (R&D)*, and the logarithm of total firm assets (*Log(Total Assets)*), respectively.  $R^2$  and Adjusted  $R^2$  present how well the regression measures the relationship between the sample data and the variables isolated. \*\*\*, \*\*, and \* denote statistical significance at the .01, .05, and .10 rounded levels (two-tail), respectively.

Variable	Coefficients	Standard Error	t-Stat	P-value	Heteroscedasticity Consistent		
					Standard Error	t-Stat	P-Value
Intercept	-0.0328	0.0521	-0.63	0.5296	0.05447	-0.6	0.548
Fog(Response)	0.0043**	0.0022	2.01	0.0468	0.00184	2.36	0.020
Fog(Present)	-0.0011	0.0024	-0.46	0.6492	0.00207	-0.52	0.601
Net Income	0.0277	0.0434	0.64	0.5249	0.04242	0.65	0.516
R&D	-0.0048	0.0507	-0.09	0.9247	0.06483	-0.07	0.941
Log(Total Assets)	-0.0001	0.0034	-0.03	0.9731	0.00390	-0.03	0.977
			$R^2$	0.0317			
			Adjusted $R^2$	-0.0019			
			Observations	150			

If there is no abnormal return, then I infer that the market is unsurprised by the information held within these calls. My findings suggest the opposite, there is a market reaction, represented by a jump in abnormal return on the day following the conference call date, Day 1. A jump on the following day can be explained as most conference calls occur after market close on day zero, resulting in the market reaction to take place on Day 1.

Before proceeding with more substantial estimations of relationships between the independent variable of Abnormal Return (*ABRET*) and the identified variables discussed in the prior section, an understanding of the isolated relationship between *ABRET* and linguistic complexity is helpful. I am able to identify preliminary relationships and Table 3 presents the initial regression outputs. For this study, a variable is considered to be statistically significant when its probability value, (*p value*) is less than .1, representing that the probability of a variable is sufficient to reject the null hypothesis. My

findings suggest that before controlling for any external firm factors, the complexity of the response section is increasing (i.e. positively related to) and statistically significant in describing the fluctuations in *ABRET* as indicated by a *p value* of .0399. I find the level of complexity in the presentation section to be insignificant.

Table 3 provides limited evidence of the *Fog* measures ability to explain the variations in *ABRET* because the presented regression fails to account for other determinants that may influence the abnormal return such as the firm performance over that period, the level of information asymmetry between investors and managers, or the relative size of the firm. In attempts to control such factors, Table 4 presents extended findings:

After controlling for significant other determinants of *ABRET*, the initial results found in Table 4 uphold statistical relevance. Despite the increase in *p value* of *Fog(Response)*, the linguistic complexity of management's responses maintain statistical significance in describing abnormal returns. I find neither the complexity

**Table 5** Market Timeliness of Information Appropriation. Table 5 presents the outputs of the event day controlled multivariate regression. The outputs compare the relationship between abnormal return (*ABRET*) on successive each day proceeding the conference call date and the measures of linguistic complexity *Fog(Response)* and *Fog(Presentation)*, firm performance, information asymmetry, and size, as *Net Income*, Research and Development (*R&D*), and the logarithm of total firm assets (*Log(Total Assets)*), respectively. \*\*\*, \*\*, and \* denote statistical significance at the .01, .05, and .10 rounded levels (two-tail), respectively.

Event Day	1	2	3
Intercept	0.86302	0.14547	0.03175
Fog(Response)	0.09979*	0.86361	0.98181
Fog(Presentation)	0.92418	0.16100	0.12635
Net Income	0.92823	0.51116	0.08511*
R&D	0.59693	0.23010	0.09282*
Log(Total Assets)	0.24074	0.47911	0.12344
R <sup>2</sup>	0.03333	0.03333	0.06250
Adjusted R <sup>2</sup>	0.00111	0.00110	0.03125
Observations	150	150	150

of the presentation nor any other determining factors to be remotely significant, as indicated by large *p values*. In the conference call setting, an investor focus on managerial response is understandable because priority is placed on the perspectives of management rather than the scripted presentation. The scripted section merely recounts the respective period's performance, typically publicized to the market before the call. In contrast, managerial responses provide specific information in real time to pointed questions from analysts; therefore, such answers are more significant to investors seeking new information or a different perspective from insiders.

To determine the extent to which either the regression outputs of Table 3 or 4 explain the behavior of *ABRET* in the following 60 trading days, I investigate the R<sup>2</sup> and Adjusted R<sup>2</sup> values. These values measure the model's ability to "fit" the datasets and are referred as a percentage of variation in the data. For instance, in Table 3, I find a R<sup>2</sup> value of .0284 and adjusted R<sup>2</sup> of .0152 indicating that only 2.84 and 1.52 percent of the variation in the dataset is explained by the complexity. In Table 4, the regression, R<sup>2</sup> increases to 3.17 percent, but the Adjusted R<sup>2</sup> turns negatives effectively rendering it as zero (indicating the model may be a poor fit). For comparison, it is important to note that publishable studies enjoy only a marginal increase in R<sup>2</sup> ranging from 0.00 to 0.29<sup>10</sup>.

Slight values for R<sup>2</sup>, adjusted or not, initially evokes pessimism in a researcher, but through further investigation creates optimism, the shift in mindset stems from understanding the environment of abnormalities. My independent variable is just that, the cumulative abnormal return of an equity security over 60 days, and to find any relation at all is significant. This is because abnormalities in security movements are multifactorial, and are difficult to control, given the limits in re-

search design of this study. For instance, at the time of the earnings conference call, there is a plethora of signals moving through the capital markets such as an increased level of uncertainty from investors, news articles from media outlets, and all quantitative information. With enough variables in a regression, one would observe higher values of R<sup>2</sup> of the *ABRET* model, but because of the focused nature of this study, it is logical to only describe between 1 and 3% of the abnormal return. Nevertheless, the findings from Table 4 suggest the confirmation of H<sub>1</sub>, that the magnitude of the PEAD is associated with the relative complexity of managerial conference call language.

The results in Table 5 suggest the market reaction to the level of linguistic conference call complexity is positively associated with the time delay of the PEAD. Specifically, managerial responses, as represented by *Fog(Response)*, are statistically significant within a 10 percent probability of rejecting the null hypothesis. *Fog(Response)* presents a *p value* of .09979, supporting my second hypothesis (H<sub>2</sub>) that there is a relationship between linguistic complexity and the time delay of the PEAD. Although these results are encouraging, the sample evidence fails to support an extended PEAD, that is a drift beyond one day, suggesting that external market participants require only a slight time delay to fully process the increased level of complexity. Additionally, conference calls are typically held following the market close, thus an increased abnormal return is expected because the majority of trades occur upon open the following day.

## 5 CONCLUDING REMARKS

Despite limitations of this research as they relate to the robustness of statistical analysis and usage of the *Fog* index, the results derived are novel and prompt future

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research. Such future studies should consider utilizing multiple complexity measures, that is to say not simply the *Fog* index, to offset these potential validity concerns, doing so will also increase the generalizability of the results within the conference call setting. I encourage future work to investigate other aspects of verbal and textual complexity from different sources as driving forces behind the PEAD. Regardless, these findings suggest that managers should continually exercise caution when disseminating information to analysts.

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**7 EDITOR'S NOTES**

This article was peer reviewed.

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# Perfect Circles: A Study of the Scattering Regions of Wolf Rayet Binary Stars

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## Abstract

Although we have been able to develop an understanding of many aspects of stellar evolution and formation, a few key gaps remain. One is the fate of massive binary star systems composed of Wolf-Rayet (WR) and O-type stars. In these WR + O binaries, the stellar winds surrounding these stars collide, creating a complex interaction region in which light from the stars scatters and becomes polarized. To study these scattering regions, I employ a technique that allows me to map the polarization of the light emitted from these stars and track its variation over the binary orbit. I found that although we have some models for this behavior, they do not fully reproduce the observed data, suggesting these systems are more complex than previously known. The unexplained behaviors give clues to the complexity of these systems and shows how these models can be improved upon in the future. Understanding the structure and evolution of this scattering region could be the key to understanding the lives and eventual deaths of these stars.

**Keywords:** Binary star systems – spectropolarimetry – astronomy – polarization – Wolf-Rayet Binaries

## 1 INTRODUCTION

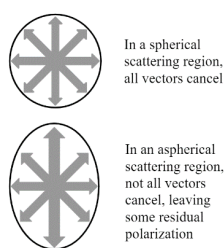
Although up to 85% of stars exist with companion stars, in stellar systems known as binaries, many of these star systems are not well understood<sup>1</sup>. Their evolution and ultimate fate can be dramatically altered by existing in a binary, especially in cases where matter is being exchanged between the stars.

One of these types of star systems involves the pairing of a Wolf-Rayet (WR) star, which is an evolved massive star that has a particularly active stellar wind, and an O-type star, which is a massive main-sequence star, upwards of 15 times the mass of the sun (Crowther 2007). A main-sequence star is one that is still undergoing nuclear fusion in the core of the star, like our Sun, and can be thought of as the middle, stable, period of a star's life. The small distance between the stars and the exchange of mass due to the stellar winds creates what is known as a scattering region – a cloud of gas and dust in and around the system. Some of the light we observe from these stars may have been scattered by this material.

This scattering region can be measured and observed several different ways. One of these ways is through polarimetry, which is a technique that measures the orientation of light coming from interstellar objects. Polarization can be thought of as the preferred direction of

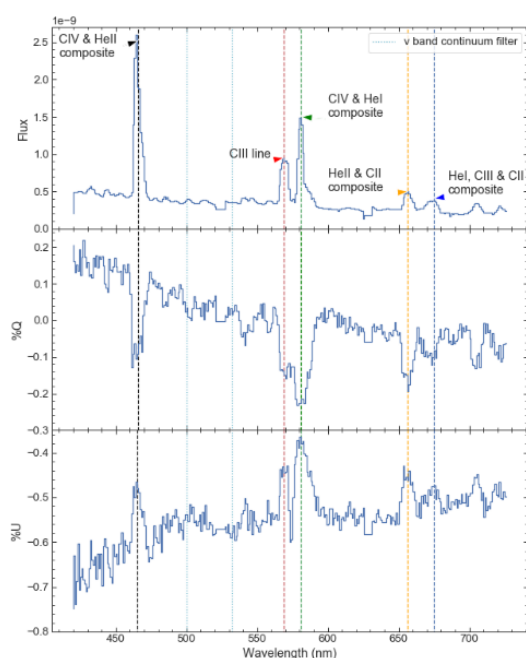
the light. As shown in Figure 1, in a perfectly spherical scattering region the polarization vectors cancel, yielding no intrinsic polarization, or no preferred direction of the light. However, if the scattering region is elongated, we measure a net polarization and its position angle can tell us the direction in which the scattering region is elongated. Another way to characterize these objects is to observe their chemical makeup, or spectrum – again through the light they emit. The combination of these techniques yields spectropolarimetry, which helps to paint a more complete portrait of the system. We used the Robert Stobie Spectrograph (RSS) spectropolarimeter on the 11-m Southern African Large Telescope (SALT) to obtain spectropolarimetric data on several of these WR + O star binary systems. I focus here on two of these systems, WR 42 and WR 79. These two stars have nearly the same period – which is the amount of time it takes for the stars to complete one full orbit around each other.

Both systems also contain almost identical stars, each having a WC7 star and a O5-8 star, both of which are specific designations of their respective star types. An O5-8 star is a massive main sequence star that is slightly cooler than the hottest stars known. A WC, or Wolf-Rayet carbon star, is categorized by the presence of strong carbon emission lines from the hot stellar



**Figure 1.** Polarization Vectors. A depiction of spherical (top) and aspherical (bottom) scattering regions.

winds (Crowther 2007). Some of these emission lines are shown in the top panel of Figure 2.



**Figure 2.** Flux, %Q, and %U vs Wavelength of WR 79. This is a single-phase graph of 0.999 phase, showing the flux, %Q, and %U against wavelength. Several carbon emission lines are identified as well as the region for the continuum filter

These two stars differ primarily in their inclination angle, which is the angle at which the system is tilted relative to our viewpoint. This makes them excellent candidates for determining the underlying structure of these objects, since their differences can be largely attributed to the different angles at which we view the two systems.

## 2 METHODS

We receive polarized spectra from SALT on each of our two binaries. Each spectrum measures the observed polarization at each wavelength between 400 and 700 nanometers with a resolution of 0.1 nm. We convert this spectrum to a more usable form by applying various

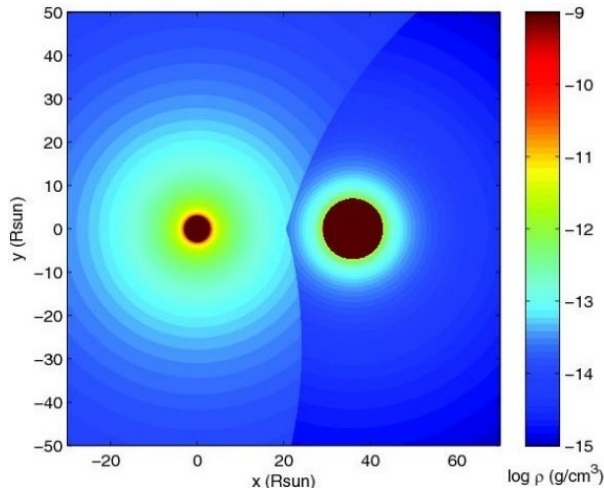
filters using Python. These filters reduce regions, or bins, of the data into a single point, and from this reduction we can produce Stokes parameters. These parameters can be thought of as a polarization coordinate system that allow us to map the data onto physical parameters. We also perform a calculation for orbital phase, which is the positioning of the stars in their orbits at the time they were observed. By calculating this phase, we are able to observe how the star and its polarization evolves as the stars rotate around each other.

The filter calculation returns two Stokes parameters, %Q and %U. Stokes parameters can be thought of as a kind of coordinate system, where a higher %U indicates more polarization at 45 and 135 degrees, and a higher %Q indicates the same at 0 and 90 degrees. I can plot the variations of these basic parameters using Python scripts. These graphs tell us about how the polarization of the system varies as a function of orbital phase, or the position of the stars in their orbit. These graphs can also tell us about the structure of the scattering material. For example, if one star exhibits a higher level of polarization in %Q, then likely there is more scattering material elongated at that angle (0 and 90 degrees on the sky).

One of the ways we analyze this data is in the form of continuum polarization. This can be thought of as the polarization of the spectral regions in between the emission lines, which arise from the stellar surfaces. The filters we use return three different bands – b band, which is centered around 427 nm, v band (516 nm), and r band (600 nm). The data has a higher uncertainty near the edges of the detected spectrum, so we primarily focus on the v-band. Using these continuum regions allows us to avoid polarization from the carbon lines, which likely exhibit different behavior. The largest contribution to the continuum polarization is O-star light scattering off the WR wind. Figure 3 shows a computer model of this scattering region in the WR + O binary V444 Cygni, with the O-star rotating around the WR creating a bow-shock region. This model of the scattering region of V444 Cygni can help give us an idea of what the scattering regions could look like for WR 42 and WR 79, as well as identify some of the features present in the continuum polarization.

When we examine these graphs of polarized light, inherently they contain some extraneous polarization – polarization not originating from the star system. Aside from instrumental error, the strongest extraneous contributor is interstellar polarization (ISP), caused by light scattering in the gas and dust between us and the object being observed. Previous studies of WR 42 and WR 79 done by Moffat et al. have estimated the ISP contribution for these stars, which we adopt here (Moffat et al. 1993). By subtracting those estimates for interstellar polarization from our SALT data, we can get a better sense of what the intrinsic polarization of these stars is,

## Perfect Circles



**Figure 3.** WR + O Scattering Region. A computer model of the wind scattering region between the WR star (left) and the O-star(right) in the WR+O binary V444 Cygni (Lomax et al. 2015)<sup>2</sup>

which is critical to understanding the scattering region.

Current models of these WR + O systems assume that the scattering region that surrounds the system of stars is ellipsoidal Brown et al. 1978<sup>3</sup>, hereafter BME). Although this is a simple model, it has proven to be accurate when considering continuum polarization. It predicts the continuum polarization should behave roughly sinusoidally with phase. This periodic behavior has been observed by St. Louis et al.<sup>4</sup> for both WR 42 and 79. Non-sinusoidal behaviors may occur when evaluating line polarization, which is outside the scope of this paper.

The BME model assumes that both stars are point sources, or that they can be approximated as massless and size-less dots, and that the ellipsoidal scattering region is centered around one star and is optically thin, meaning it has a low density. Both are simplifications but can still provide us with an idea of the scattering region and the evolution of these star systems, without making calculations immensely complicated. From these base assumptions, the authors derive an analytical formula to describe the polarization variation with phase. In this formula,  $q_0, q_3, q_4, u_0, u_3$ , and  $u_4$  are dependent variables and phase is an independent variable.

$$q = q_0 + q_3 \cos(4\pi * \text{Phase}) + q_4 \sin(4\pi * \text{Phase}) \quad (1)$$

$$u = u_0 + u_3 \cos(4\pi * \text{Phase}) + u_4 \sin(4\pi * \text{Phase}) \quad (2)$$

Using Python, I performed least squares fits to compare this theoretical sinusoidal curve with our SALT data for WR 42 and WR 79. The Stokes parameters returned by this model can be manipulated and graphed in the same ways as the original Stokes parameters and

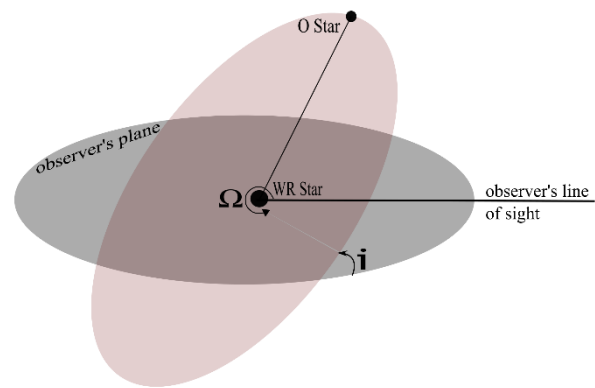
provide a hypothetical picture of the scattering region to compare our results with.

The BME model also provides us with some properties of the system, namely the inclination angle ( $i$ ) which is the angle at which we view the system,  $\Omega$  which is how the orbit is projected onto the sky, and  $\lambda_2$ , which is the angle of the distribution of material in the scattering region as measured from the line between the stars. These parameters are further explained in Figure 4. The inclination angle is calculated as follows:

$$x = \frac{(u_3 + q_4)^2 + (u_4 - q_3)^2}{(u_4 + q_3)^2 + (u_3 - q_4)^2} \quad (3)$$

$$i = \cos^{-1}\left(\frac{x^{\frac{1}{4}} - 1}{-x^{\frac{1}{4}} - 1}\right) \quad (4)$$

Following the algebra from Drissen et al.<sup>5</sup>, I calculated the values for  $\Omega$  and  $\lambda_2$  for my two binaries.



**Figure 4.** Orbital Properties. In this figure, the ecliptic plane lies along our line of sight.  $i$  is the angle between the ecliptic plane and the plane of the orbit of the O-Star.  $\Omega$  is the angle of the O-star's orbit projected onto the sky.

Any deviations from this theoretical model could indicate that the initial assumption of a symmetric ellipsoidal scattering region was an incomplete picture. For example, the WR star wind might have a more complex geometry, or scattering might occur in regions other than the WR wind<sup>6</sup>. The presence of behavior consistent with an aspherical scattering region could indicate that our current model and understanding of these WR + O binaries is not complete, or that some of the simplifying assumptions made are not as close an approximation as hoped.

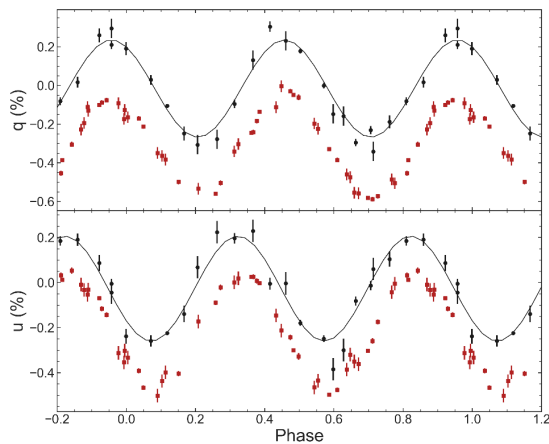
A previous study of these two objects by SL87 provides us a point of comparison for our data. Their data utilized a wide b-band filter for the continuum data and exhibits a close match to the BME fit.

Since the polarization across the three continuum bands is very similar, we combined the data from all three filters in an error-weighted average. This reduces

uncertainties on the measured values and allows us to do a more direct comparison of our data with the SL87 data, as the error-weighted average is closer to the filter than any of our individual data. Additionally, since electron scattering is spectrally grey—meaning it doesn't change with wavelength—performing this error weighted average does not lose any spectral information.

### 3 RESULTS

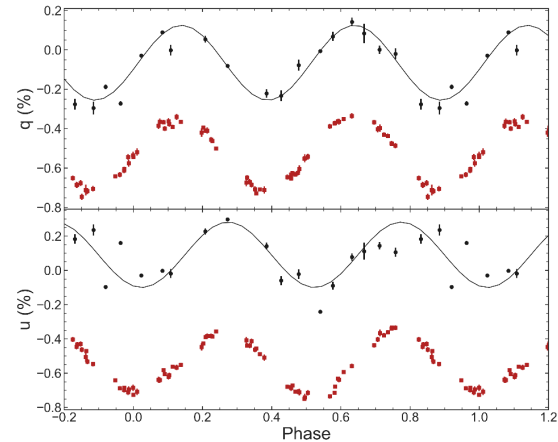
Figures 5 and 6 show the error weighted average of the SALT data for WR 42 and WR 79 respectively compared with the continuum data from St. Louis et al. (SL87)<sup>4</sup>.



**Figure 5.** WR 42 Error-Weighted Average Comparison with BME Fit. Displays the error weighted average (black circles) continuum polarization of WR 42 and compares it with the wide b-band polarization (red squares) data from St. Louis et al.<sup>4</sup>. The black curve is the BME curve fit to the error weighted average following ISP Subtraction. The St. Louis data has been phase shifted by +0.09.

Their data is used as a point of comparison because of the low systematic error present, and because they have a significant amount of data on these objects. Tables 1 and 2 display the BME parameters calculated for the SALT WR 79 and SALT WR 42 data respectively. These values are used for the calculations of the three primary parameters:  $i$ ,  $\Omega$ , and  $\lambda_2$ .

The SALT data for WR 42 tends to have more variability in both % $q$  and % $u$ , although the fit calculated from this data does match the SL87 data well. WR 79 exhibits less variation from this theoretical curve; almost all data points lie on the curve, within their uncertainties. It is worth noting that WR 79 is a brighter star system, which greatly improves our ability to accurately observe this object. Further comparison of the two data sets reveals slight phase offsets for both stars. WR 79 requires an additional 0.04 phase, and WR 42 requires an additional 0.09 phase. In order to align our data with that of SL87,



**Figure 6.** WR 79 Error Weighted Average Comparison. The same but for WR 79. The St. Louis data has been phase shifted by +0.04.

we added constant phase offsets to the SL87 data (0.09 for WR 42 and 0.04 for WR 79). This phase shift could be due to a gradual change in the orbital period of each system as the stars exchange mass, or the result of uncertainty in the phase calculations. Also, worth noting is the slight phase offset between % $q$  and % $u$  for each star across all bands. This offset may indicate a minor asymmetry in the distribution of scattering material in the systems. This average also exhibits strong periodic behavior in both % $q$  and % $u$  for both star systems. In particular, the error weighted average for WR 42 returns data that more closely matches previously observed trends than the individual bands do. By contrast, in WR 79 it appears to have further exaggerated the differences in % $q$  and % $u$ . Table 3 shows the calculated primary parameters for the BME fit based upon our error-weighted average data for each star, while Table 4 shows the same parameters calculated by SL87. Our values for inclination angle agree within uncertainties with those from SL87. The values for  $\Omega$  and  $\lambda_2$  for WR 42 are consistent with those calculated by SL87.

Interestingly, WR 79 presents quite different results for both  $\Omega$  and  $\lambda_2$ . The uncertainty estimates we used are based on Wolinski & Dolan<sup>7</sup>. This method includes the inherent biases in polarimetry that the fit errors cannot include because they are synthetic. The dominant contributors to these estimates are systematic instrumental uncertainties, not uncertainties due to the curve fitting. Because Wolinski & Dolan developed their prescription after SL87 published their data, the error estimates in the SL87 data do not include correct error estimates for  $\Omega$  and  $\lambda_2$ <sup>7</sup>. An increase in the uncertainties on the SL87 parameters for WR 79 may allow for my parameter fit results to match within error.

**Table 1** BME parameter values for WR 79. These are the BME parameters returned for the SALT WR 79 data following an ISP subtraction

q0	$-0.065 \pm 0.003$	u0	$0.091 \pm 0.003$
q3	$-0.034 \pm 0.004$	u3	$-0.182 \pm 0.004$
q4	$-0.130 \pm 0.005$	u4	$-0.057 \pm 0.005$

**Table 2** BME parameter values for WR 42. The same as in Table 1, except for WR 42.

q0	$-0.016 \pm 0.005$	u0	$-0.027 \pm 0.005$
q3	$0.216 \pm 0.007$	u3	$-0.143 \pm 0.007$
q4	$-0.130 \pm 0.007$	u4	$-0.184 \pm 0.007$

#### 4 DISCUSSION AND CONCLUSION

Although our data match the BME model quite well generally, there are some slight deviations worth noting. These could indicate that some of the base assumptions we made in applying this model are inaccurate. The BME model assumes a low-density scattering region around the system, which implies low-density winds for both the O star and the WR star. WR stars are known to have very dense, opaque winds (Crowther 2007), so the deviations present in our data from the model's predicted curve are likely due to a higher density scattering region than allowed for in the model.

Figures 5 and 6 also show that the average values for %q and %u are not centered at zero polarization. There are two primary reasons that we may have some constant intrinsic polarization: the first is that we may not be subtracting all the interstellar polarization, and the second is that there is an additional elongated scattering region in the system that is not accounted for by the BME model. In my future work on these binaries, I will investigate both these scenarios.

The previous study done on these objects by SL87 provides a standard to which we can compare our results. Their study investigating the polarimetric behavior of WR + O binary systems reveals a similar sinusoidal trend that largely matches the BME model. Additionally, they have a large dataset and low systematic error, which makes it a good point of comparison for our data obtained from SALT. The error-weighted average of the three bands of our data does not exactly correspond to the SL87 results; both stars required a slight phase offset to match the SL87 data. Given the amount of time between the different observation periods and the uncertainty of the phase calculations, it is reasonable to infer that slight changes in the orbit or circumstellar material configuration have occurred between the two datasets.

Some of the discrepancies between our values for  $i$ ,  $\Omega$ , and  $\lambda_2$ , and the ones obtained by SL87 can be explained in part by the different filters used to acquire the data. SL87 used a wide blue filter centered at 470 nm with a width of 180 nm. In a WC7 star like WR 79 or WR 42, this

filter covers the 465 nm/468 nm line region, which is the strongest emission line present in these stars. Since this filter works to essentially obtain an average value of polarization for that spectra, if this line were highly polarized, it would pollute the "continuum" data.

Wolinski & Dolan<sup>7</sup> showed that when measurement uncertainties become significant, the BME model returns an over-estimation of the value for the inclination angle. In our case, this effect is exacerbated by our relatively sparse data points over the orbital cycle. Since all further calculations are based upon this initial value for  $i$ , any error introduced here will be further amplified. This may help to explain the difference between our calculated fit parameters and those found by SL87.

Although the BME model of the scattering regions of these stars can provide a basic model of their behavior, it is not able to fully capture the complex nature of the stellar winds. Deviations from this hypothesis are present in the phase shift between %q and %u, as well as in the inconsistent values for the inherent properties in the stars. These deviations may indicate that there is some intrinsic polarization caused within the system itself and that the scattering region around this system is much denser than assumed.

Though a look at the continuum polarization of these star systems can provide a glimpse into their basic structure and evolution, more detailed observations and conclusions can be drawn through examination of their line polarization and interstellar polarization. We have a method of extracting polarization within the strong emission lines, which are known to exhibit different behavior than the continuum in these binaries. In the next step of this project, I will compare these emission lines with the continuum and with each other. Through this analysis, we can begin to map the wind interaction regions to provide a clearer picture of the life of these stars.

This research indicates that our current model for the behavior of these systems is incomplete. To better capture the nature and evolution of these scattering regions, and of these binary systems, we need a model allowing for dense stellar winds and for polarization

**Table 3** RSS/SALT BME Parameters. Binary system parameters derived from the BME fit to the error-weighted average of the three continuum polarization bands for each star.

	WR 42	WR 79
<b>Inclination Angle (i)</b>	$53^\circ \pm 6.3^\circ$	$55^\circ \pm 3.9^\circ$
<b>Omega (<math>\Omega</math>)</b>	$-46^\circ \pm 20^\circ$	$-29^\circ \pm 15^\circ$
<b>Lambda_2 (<math>\lambda_2</math>)</b>	$-29^\circ \pm 10^\circ$	$3^\circ \pm 9^\circ$

**Table 4** St. Louis BME Parameters. Binary system parameters derived by SL87 from their wide b-band continuum polarization.

	WR 42	WR 79
<b>Inclination Angle (i)</b>	$43.5^\circ \pm 5^\circ$	$44.8^\circ \pm 5^\circ$
<b>Omega (<math>\Omega</math>)</b>	$-43.8^\circ \pm 9.3^\circ$	$34.4^\circ \pm 8^\circ$
<b>Lambda_2 (<math>\lambda_2</math>)</b>	$-26.5^\circ \pm 5.7^\circ$	$-44.8^\circ \pm 3.6^\circ$

arising from light scattering in the WR wind. Further analysis of these binaries using line polarization will help to determine possible structures of those scattering regions and provide insight into how changing stellar wind densities and polarizations affect the life of these stars.

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## 5 EDITOR'S NOTES

This article was peer reviewed.

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# The Cycle of Failing Reform: How Mentally Ill Detainees Continue to Suffer Unconstitutional Wait Times in Colorado

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## Abstract

This research examines the state of Colorado's failing criminal justice system, particularly as it pertains to mentally ill detainees. For several years, mentally ill detainees in Colorado have been forced to wait for extensive amounts of time to receive court-ordered evaluations to determine mental competency before trial. The state's continued failure to administer these evaluations in a timely manner has led to a series of complaints and lawsuits against the state. Unfortunately, these lawsuits have ultimately done little to create lasting reform. The state has managed to temporarily mitigate the problem as complaints of unconstitutional wait times arise, but it has historically disregarded the broader failures in the criminal justice system. Outpatient, community-based programs may be more beneficial to mentally ill detainees than a state forensic hospital.

**Keywords:** Detainees, competency evaluation, federal lawsuit, Colorado, path dependency, criminal justice

## 1 INTRODUCTION

Over the past eight years, the state of Colorado has faced numerous lawsuits regarding the unconstitutional wait times for detainees in the criminal justice system who suffer from mental health issues. Individuals who have been accused of crimes but have not yet been charged wait as long as six months to receive a court-ordered evaluation to determine mental competency before trial<sup>1</sup>. Those who are evaluated as mentally incompetent face even longer waiting periods to receive treatment at state forensic mental health hospitals. The excessive wait times are often longer than the wait times that detainees would need to serve if actually charged with the alleged crime<sup>1</sup>. This injustice has led to many complaints by the accused and their families and it has sparked the advocacy group Disability Law Colorado (DLC) to sue the state in order to mandate reform.

This research aims to investigate the reasons why federal lawsuits were brought on by the DLC against the state of Colorado, the steps the state has taken since the filing of the lawsuits, and the reasons for a recent influx of people charged with crimes that require court ordered evaluations. Further, this paper examines the impact of the lawsuit on state litigation and thus mental institutions within the region. The state's ability to create effective and sustainable change for mentally ill detainees is hindered by continued use of methods

based on precedent rather than efficacy, a phenomenon known as path dependence. Path dependence increases the likelihood that prolonged wait times for mentally ill detainees will continue to go unsolved and instead repeat in the same cyclical pattern of failing reform.

A thorough examination of how Colorado's criminal justice system impacts mentally ill detainees through mental competency evaluations is a necessary addition to current criminology literature. By addressing specific aspects of the state of Colorado's system, this research can be applied to the broader context of the nation's criminal justice system. State comparisons have the capability to reveal approaches to reform or even demand reform on a larger scale. Such literature can move states and local governments away from path dependence, thus increasing the chances of significant and lasting reform.

## 2 METHODS

The research to generate this paper first explores a series of local news articles, ranging from sources like the Denver Post to online publications of the Colorado Public Radio. These articles were discovered from databases such as World Access News and the criminology and sociology database, using search terms such as "mentally ill detainees," "Colorado criminal justice reform,"

“federal lawsuit,” and “mental health in the criminal justice system.” Dates for these articles range from as early as the initial lawsuit filed in 2011, up to the fall of 2019. These news pieces emphasize an easily understandable outline of the basics of each lawsuit, the major actors involved, and the consequences of their actions in regards to the paper’s topic.

At the end of the news articles, there were often links to more materials and the actual lawsuits mentioned in the writing. With the use of these resources, extensive research was done to read and sort through the litigation in chronological order, gaining a better comprehension of how the state has reacted over the years and how various complaints have resulted in the amending of certain lawsuits. This resulted in findings about people involved, such as the head of the Colorado Department of Human Services, as well as major groups, like DLC. These sources comprise a thorough outline of the history of this issue over the past nine years and even before the initial lawsuit in 2011. They also yield a detailed analysis of who and what has contributed to the prolonged wait times of mentally ill detainees.

### 3 FINDINGS

Under both Colorado state law and federal law, an incompetent defendant cannot stand trial. However, the process to determine competency—a defendant’s ability to have rational understanding and consult with the lawyer to assist in one’s own defense—is long and complicated in and of itself<sup>1</sup>. Questions of competency can be raised by the trial judge, prosecution, or defense, and the court can determine a preliminary finding of competency. This preliminary finding of competency will be the final decision unless another party objects within ten days<sup>1</sup>. In the case that another party does object or that the court does not possess enough information to make a preliminary finding, the court orders that a competency evaluation be carried out for the defendant by the Colorado Department of Human Services (CDHS)<sup>2</sup>. Once again, a party has ten days from when the evaluation report is received to request a hearing or second evaluation, and, if no case is made, then the court’s determination of competency to stand trial becomes final<sup>1</sup>.

The trial court determines where these evaluations occur, and the defendants are often taken into custody by the CDHS until the evaluation takes place. The evaluations happen in one of three ways: in the psychiatric hospital at the Colorado Mental Health Institute at Pueblo (CMHIP), in the jail where the defendant is detained by a contract evaluator hired by CMHIP, or outside of jail for defendants released on bond<sup>1</sup>. If it is decided that the defendant is not competent enough to proceed with trial, the court can release the defendant on bond to receive treatment services or, in the case

that the defendant is not eligible for bond, custody is granted to the CDHS to carry out restorative treatment<sup>1</sup>. Not only can the process of determining competency take several weeks, but if the defendant is committed to the CDHS’s control, it can take up to several months to receive the necessary treatment due to backlogs at CMHIP caused by insufficient space and understaffing. Unfortunately, very little information is available as to what exactly comprises these competency exams, and there is not much information regarding the processes of restoration treatment at CMHIP either, except that services are carried out by professionals involved in “nursing, psychology, social work and medicine.”<sup>3</sup> If this information is a matter of public record, further research should be done to understand the specifics of these competency evaluations and restoration treatments to better hint at the nuances of the state’s issues and why exactly the state is struggling to deliver evaluations and treatment in a timely manner.

CMHIP is a 455-bed hospital that administers inpatient behavioral health services for people involved in the criminal justice system<sup>3</sup>. According to their website, CMHIP “serves individuals with pending criminal charges who require evaluations of competency, individuals who have been found by a court to be too incompetent to proceed (restoration treatment), and individuals found to be not guilty by reason of insanity.”<sup>3</sup> For having less than 500 beds, the treatment center has a lot of responsibility to aid a very diverse group of people involved in the criminal justice system. Much like parole and probation, there are far too many people involved in the carceral state who require mental health treatment compared to the small amounts of staff and trained professionals needed to administer these required resources; the ratio of staff to patient is much too large. Without individualized, or at least small group, treatment with trained staff, mentally ill detainees risk being lost in the system, rather than receiving the personal treatment they need in order to recover. Furthermore, at the time of the initial 2011 lawsuit, no Colorado jails could allocate treatment, and CMHIP was the only state forensic mental hospital equipped to provide court-ordered evaluations and accept custody of pretrial detainees for restorative treatment<sup>1</sup>. Given the large number of individuals in need of these services, especially in more recent years, additional pressure has been placed on CMHIP to maintain effective staffing and resources for these people.

In 2011, the same year the first major lawsuit was filed against the state of Colorado, a waitlist existed of more than 50 people waiting for admittance into CMHIP for restorative treatment. Many of these detainees suffered from severe mental health issues, which remained untreated for up to six months and oftentimes getting much worse during that period<sup>1</sup>. Furthermore, the detainees who were not eligible for bond had to spend

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the time in local jails with a living environment that only exacerbated their mental health problems. While “a defendant may not be confined for restorative treatment for a period in excess of the maximum term of confinement that could be imposed for the offense with which the defendant is charged,” this has often been the reality for these detainees<sup>1</sup>.

This backlog at CMHIP and the delays in administering competency evaluations also puts immense pressure on local sheriffs and their departments. Their jails are left to take care of these detainees, who are often much more difficult and expensive to jail than those who do not suffer from mental health issues<sup>1</sup>. For example, the Arapahoe County Sheriff reported in 2010 that it took an average of 43 days for a competency evaluation to be carried out in jail after the initial court order. In 2011, the average increased to 51.6 days, with it once taking more than eight weeks—58 days, to be exact—for a detainee to receive the evaluation<sup>1</sup>. The Arapahoe Sheriff also saw delays for admission to CMHIP after finding incompetency, with an average wait time of 26.25 days from the court order for commitment to actual admission to the institute in 2010, and an increase to 32.5 days in 2011<sup>1</sup>. These detainees’ presence in local jails exhausts much of the jails’ resources meant for the other incarcerated individuals, like those serving short sentences or those awaiting trial who do not have mental health issues, and it costs significantly more money to jail those suffering from mental illness. The price to house one inmate for a day at the Arapahoe County Detention Facility is \$68.30, but, to house a mentally ill detainee, that price doubles<sup>1</sup>. Local jails are having to incur these costs more often than they should due to the state’s failure in timely admittance of detainees for their evaluations and treatment.

Even though the primary lawsuits examined in this paper are between DLC and the state of Colorado, the persistent problems regarding mistreatment of detainees, prolonged wait times, and understaffing in treatment facilities manifested long before DLC’s original 2011 lawsuit. In 1999, for example, the first sign of systemic failure was revealed through the Neiberger federal lawsuit, in which patients at CMHIP filed complaints for negligence in the facility as well as violations of their due process<sup>4</sup>. This led to a 2002 settlement that resulted in the CDHS agreeing to fill vacant staff positions and maintain staffing ratios at CMHIP, as understaffing was found to be one of the main causes of mistreatment at the institute<sup>2</sup>.

Further showing the history of incompetency by the state was the Zuniga case, which occurred just four years later. The CDHS had to answer a citation by a Denver District judge for failing to admit pretrial detainees for competency evaluations and restorative treatment in a timely manner<sup>2</sup>. In fact, by the end of 2006, around 85 people were waiting to be transported to CMHIP for

treatment<sup>1</sup>. The Department “blamed staffing shortages and increased numbers of court referrals as the cause for delays,” clearly showing that the settlement for the Neiberger case was ineffective in rectifying staffing issues<sup>2</sup>. The state refused to change their ways, and instead they demonstrated path dependency by maintaining their traditional procedures. In 2009, the agreement reached by the Zuniga settlement expired with the opening of more than 200 additional beds on the CMHIP campus<sup>2</sup>. However, as similarly demonstrated by mass incarceration, the creation of more beds often leads to the automatic filling of those beds to reduce backlog, rather than actually addressing the underlying factors creating the problem. When the new forensic institute was added to the CMHIP campus, it had the opposite effect of reducing backlog and instead created even longer delays to receive treatment at the facility. This was due to the fact that the institute was never properly staffed from its creation and not prepared to receive the high volume of court referrals<sup>2</sup>. By January of 2010, pretrial detainees once again suffered the violation of constitutional rights when significant delays became the norm<sup>1</sup>.

In 2011, DLC finally got involved to address the mounting backlogs by filing a lawsuit against the state of Colorado. DLC “protects and promotes the rights of people with disabilities and older people in Colorado through direct legal representation, advocacy, education and legislative analysis.”<sup>5</sup> Because these unconstitutional wait times were greatly affecting people with mental health issues and even making their illnesses worse, DLC believed it was their responsibility to become a driving force of reform.

The group filed the original federal lawsuit on August 31, 2011, naming Reggie Bicha, the Executive Director of the CDHS, and Teresa Bernal, the Interim Superintendent of CMHIP, as the defendants<sup>1</sup>. At the time, DLC went by the name “The Legal Center for People with Disabilities and Older People,” and as such the lawsuit’s title was abbreviated to Center for Legal Advocacy v. Bicha<sup>5</sup>. In the lawsuit, DLC argued that the pretrial detainees, “who have been charged with but not convicted of crimes, have constitutionally protected liberty interests in promptly receiving such evaluations and treatment while not being confined any longer than necessary.”<sup>1</sup> They cited that, in the most severe cases, some detainees have waited for treatment for as long as half a year<sup>1</sup>. These excessive wait times violate the United States Constitution by depriving individuals of their due process rights and taking advantage of people who are often unable to protect themselves<sup>1</sup>. Detainees are also guaranteed the right to a speedy trial under the Sixth Amendment, but the state of Colorado’s own speedy trial statute excludes the time that is spent to evaluate detainees’ competency, meaning they could be forced to wait for an indefinite amount of time for

evaluations or treatment without technically being in violation of the statute<sup>1</sup>.

In addition to outlining the major issues and key actors, the lawsuit also included descriptions of many individual cases, emphasizing the exact wait times detainees suffered and demonstrating their breach in constitutional rights. For example, Client L.E., who at the time was represented by the Colorado Public Defender, was ordered to receive a competency evaluation by Judge D. Archuleta on December 30, 2010. It wasn't until almost a month later, on January 28, 2011, that the evaluation occurred at the Boulder County Jail. Another ten days passed before L.E.'s evaluation was filed with the court on February 7, 2011, and on February 14, the court finally determined L.E. was too incompetent to proceed with trial and required transportation to CMHIP for restoration. Client L.E. waited more than five months before finally being transported to CMHIP on July 15, 2011<sup>1</sup>. L.E. is just one of countless examples, and many more instances of injustice were included as evidence in DLC's complaint against the state.

Center for Legal Advocacy v. Bicha ultimately resulted in a settlement agreement in 2012 between the CDHS and DLC. The main condition of the agreement required the CDHS to file monthly reports with DLC, demonstrating that they were fulfilling the agreed upon 28-day timeline to complete competency evaluations<sup>2</sup>. DLC adopted a monitoring role to ensure the CDHS followed all procedures and remained in conjunction with their agreed upon provisions. For the first two years following the settlement, the state managed to timely admit pretrial detainees for their court-ordered evaluations<sup>2</sup>. Additionally, the Office of Behavioral Health at the CDHS created a jail-based evaluation and restoration program in 2013, designed to "[provide] daily psychiatric care and competency restoration treatment through individual and group sessions; structured similarly to services provided at the Colorado Mental Health Institute at Pueblo (CMHIP)."<sup>6</sup> The program is also designed to "routinely [assess] for goodness of fit and [transfer] [individuals] to a hospital setting if necessary."<sup>6</sup>

However, in 2015, the CDHS once again began facing issues concerning their treatment of mentally ill detainees. The admissions policy to CMHIP was changed by the CDHS without the knowledge of DLC, and these new policies limited the number of those admitted to the facility<sup>2</sup>. This produced a waitlist and generated another backlog of approximately 100 detainees who were determined incompetent and awaiting treatment at the center. As was the case with the Zuniga lawsuit, the CDHS once again cited staffing shortages and a spike in the number of referrals as the main causes of the backlog<sup>2</sup>. By using the same excuses, the state admitted to their lack of action and response to the previous lawsuits, further showing the effects of path

dependency. These actions were a breach of the settlement agreement, but rather than reaching out to DLC and explaining the situation, the CDHS tried to cover up their mistakes by submitting inaccurate reports to DLC<sup>2</sup>. These falsified reports made it appear as though the CDHS was still following the 28-day admissions deadline when they were not. DLC discovered and began investigating the CDHS's actions "when it started receiving complaints from detainees' families and their attorneys who were being told by jail staff that it will be months before admission to CMHIP."<sup>2</sup>

In 2016, DLC reopened the 2011 lawsuit to once again address these backlogs. Both parties agreed to modify the settlement agreement by appointing "an independent administrator to supervise future compliance."<sup>7</sup> The independent administrator's job, much like DLC did previously, was to monitor the CDHS's actions very closely over the next two and a half years to ensure it followed procedure<sup>7</sup>. The administrator would have access to the CDHS's operations as well as coordinate meetings each quarter to check the Department's progress<sup>2</sup>. However, DLC tried to monitor the CDHS previously and the state was still able to falsify reports. To have an independent administrator do the same work would likely not have a more effective outcome.

In response to the outcry from DLC in 2016, state officials sought help from lawmakers to give them additional time frames beyond the previously-agreed upon 28-day deadline. The state asked for 45 days, starting from the moment a person is booked into jail, to execute mental competency evaluations, as well as 150 days to treat individuals who are found to be incompetent<sup>8</sup>. Both of these wait times are excessive, especially when many of the detainees face charges with jail times that are less than those deadlines. Reggie Bicha, the Executive Director of the CDHS who was named as a defendant in the original 2011 lawsuit, claimed "it's a matter of skyrocketing numbers of people who need mental health treatment in jail."<sup>8</sup> Regardless, these requests showed the state's desire to change only the bare minimum in order to avoid penalties through litigation, rather than abandoning path dependency to seek the necessary broader reform.

Officials are also looking for alternative solutions that involve treating mental health detainees while they are in jail<sup>8</sup>. However, besides the jail-based restoration program created in 2013, which is located at the Arapahoe County Detention Facility, CMHIP is the only facility designed to provide treatment that restores incompetent detainees<sup>1</sup>. Other jails do not have the capacity to treat inmates, and would end up using all their valuable resources on mentally ill detainees as opposed to the other inmates, who also need assistance. Not surprisingly, mental health advocates and public defenders such as DLC are not supportive of mentally ill people

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receiving treatment in jail<sup>8</sup>. They argue that the most effective and beneficial form of treatment is in a community mental health care system, outside the adverse effects of the carceral state. Furthermore, advocates also oppose the state's proposition of a 150-day timeframe to administer treatment. They say the roughly five-month wait is "too long to sit in jail—and perhaps even be forcibly medicated—without being convicted of anything."<sup>8</sup>

There is no denying that the number of court-ordered mental evaluations has drastically increased over the past two decades. In 2001, 429 people were reported to receive mental health competency evaluations, compared to 2,277 evaluations in 2017<sup>8</sup>. While the data substantiates this fact, it is much harder to determine what has led to this increase in court orders. Although anyone in the court room can call into question a defendant's competency, it is the judge who holds the power to determine who does and does not require an evaluation. Robert Werthwein, the Director of the Office of Behavioral Health during the reopening of the lawsuit in 2016, believes part of the solution lies in judicial discretion. He proposes that judges should more carefully consider who does and does not require inpatient services based on the severity of offenders' mental illness<sup>8</sup>. If judges contemplate releasing more low-level offenders out of jail to receive outpatient treatment, this would allow more space within inpatient centers, like CMHIP, for the most severe cases. This is similar to Christopher Seeds' theoretical concept of bifurcation, where low-level offenders are treated differently from more serious offenders<sup>9</sup>. This method should also help clear some of the backlog in local jails and allow for better allocation of state resources. To help spread this message, Werthwein sent several letters a week to local judges to help sway their opinions. He mentioned that some took notice, but it would take a lot more support for the movement to foster significant change<sup>10</sup>.

On June 13, 2018, attorneys working for DLC once again moved to reopen the 2012 class-action settlement to address the unconstitutional wait times faced by detainees expecting competency evaluations<sup>7</sup>. This time, the complaint cited that "the wait times bear no relationship to the offenses these individuals have been charged with, which are often low-level and non-violent... The result of these lengthy, unconstitutional delays is a vicious cycle. The longer the state makes these individuals wait for evaluation and restorative services, the more exacerbated their mental illnesses become."<sup>11</sup> As officials stated, requests for competency evaluations have increased 524% since the year 2000, and in that time demands for mental health treatment by detainees have increased by 931%<sup>11</sup>. Once again, the CDHS failed to enact change and faces the same issue of people waiting months in jail for competency evaluations or treatment, even though they have not yet been convicted of any

crimes. Reggie Bicha was again named in the lawsuit, and he proposed a bill to the state legislature that gives the state "permission to treat mentally ill people in jail, rather than move them to a mental hospital or other treatment setting."<sup>11</sup> However, the bill died on the last day of the legislative session, to DLC's relief.

In late 2018, DLC created a motion for the appointment of a Special Master to address their concerns. Special Masters are officials appointed by a judge to oversee that judicial orders are carried out and to provide evidence and recommendations to the judge for how to best deal with the matter<sup>12</sup>. In the defendants' response to the motion, both Reggie Bicha and Jill Marshall, the Superintendent of CMHIP, agreed that a Special Master would be valuable "to assist the Department in implementing its plan to address compliance with the Settlement Agreement timeframes concerning inpatient competency restoration treatment and to assist the Court in addressing the complex and technical issues in this case."<sup>13</sup> On December 29, 2018, Judge Nina Wang, a United States Magistrate Judge of the District of Colorado, ordered the appointment of Groundswell Services, Inc., a small management and consulting firm in Denver, to fulfill the Special Masters role. Bicha and Marshall requested that the Court's appointment of Special Master continue "until the Department has maintained compliance with the Settlement Agreement timeframes concerning inpatient competency restoration services for three months."<sup>13</sup>

For their first duty as Special Masters, Groundswell Services, Inc. filed a report on January 28, 2019, to outline their review of the CDHS document titled, "Comprehensive Plan for Compliance," which "describes the efforts of CDHS to improve timely performance of competency services, and thereby comply with the timelines delineated in the 2016 Settlement Agreement."<sup>13</sup> In the Special Masters report, Groundswell Services, Inc. provides feedback on the CDHS's plan and recommends how they might change it to become more effective. They start by stating their belief that "most mental health services are best delivered in a broad system of care, beginning in the community, rather than solely in inpatient psychiatric hospitals."<sup>14</sup> They argue that all members of the Settlement Agreement can agree that this would be the ideal solution.

The CDHS has been struggling with this same problem for many years, and despite DLC's involvement in reopening cases and continually suing the state, it has been to little avail. DLC and many other health and advocacy programs contest that the best way to support and treat mentally ill detainees is not by spending unnecessary time in jail awaiting treatment; instead, these individuals should receive services from community resources. With these services they can remain integrated into society and thus escape the inherently adverse effects of the carceral state.

One such community treatment program was started in November 2019 by the Mental Health Center of Denver, “one of the city’s biggest community behavioral health care providers.”<sup>15</sup> The program, called Community Based Enhanced Restoration, is designed to allow patients to “live independently or with family members, and case managers will see them at least three times a week to help connect them and transport them to services from Mental Health Center of Denver and other providers, including benefits, employment, education, psychiatry and medication management.”<sup>15</sup> The program is capped at 30 but, if it is successful, the supervisor of the program hopes to create similar programs elsewhere. While supportive of the outpatient treatment plan, DLC’s director of legal services, Alison Butler, says that the difficulty with getting these kinds of outpatient programs off the ground is having clients to generate funding, but in order to have clients, the program needs referrals from judges<sup>15</sup>. Judges will likely only refer to the program if it has proven to be successful in the past, so it becomes evident that this cycle poses a major hurdle to the success of these types of programs. As Robert Werthwein previously suggested, the solution likely lies in the discretion and decisions of judges.

Contrary to outpatient treatment programs, some people still advocate that the most obvious fix is to increase the number of beds available at CMHIP so that patients can be treated immediately, instead of waiting in jail for restoration. In fact, CDHS announced in September 2019 that a new unit is being constructed at CMHIP, which will add 24 beds and is projected to open by November 2020<sup>16</sup>. This construction is part of a larger plan to add a total of 128 beds by December 2021, including 18 beds at a new jail-based restoration services location at the Boulder County Jail, and 44 beds for restoration treatment at the Colorado Mental Health Institute at Fort Logan (CMHIFL), which is traditionally for civil patients<sup>16</sup>. However, as the Neiberger case showed previously, increasing the number of beds does nothing without also being prepared to increase staffing and resources to adequately house those beds, which the state failed to do after the 2002 lawsuit. Considering that the CDHS’s latest plan to increase beds does not mention anything about how this additional unit will be staffed, it can only be hoped that the proposed \$7 million budget includes a corresponding increase in staffing and resources to prevent the ongoing systemic failures seen in the past. As construction of these new units continues in the future, it will be interesting to see if they have the intended effect of reducing backlog, or if, yet again, the issue of additional beds without additional staffing persists.

Another proposed solution is to open bed space in civil mental health hospitals, which the state has already begun<sup>14</sup>. In other words, beds for non-criminally

involved patients at mental hospitals would be reserved specifically to address the backlog of detainees awaiting trial. In December 2018, the CDHS announced a freeze on civil admissions to CMHIFL, meaning patients not involved in the criminal justice system were not able to receive treatment<sup>17</sup>. DLC’s Alison Butler said she was “dismayed by the state’s proposal,” claiming that the plan meant, “essentially, in order to get... inpatient mental health services you have to commit a crime.”<sup>17</sup> The state was attempting to solve one problem by creating another. Not surprisingly, this proposal was met with severe backlash, both because it inhibited patients who were not involved in the criminal justice system from seeking treatment and it appeared to award or incentivize criminal behavior. Only two months later in February 2019, the state agreed to remove the freeze and once again allow civil patients to be admitted for the treatment they need<sup>18</sup>.

Ultimately, a lasting solution to this problem is far more complicated than increasing the number of beds or appointing a Special Master to observe obedience. As Groundswell Services, Inc.’s January 2019 report noted, the CDHS’s plan to come “promptly into compliance with the Settlement Agreement is not the same as a comprehensive plan to improve Colorado’s civil and forensic mental health services.”<sup>13</sup> For the state to finally fulfill consistent and reliable compliance, the broader healthcare system must be reformed. In March 2019, a consent decree was filed in federal court to close the most recent lawsuit between DLC and the CDHS and attempt to create a comprehensive plan to address the backlog of those waiting for competency evaluations once and for all<sup>19</sup>. The agreement “sets up a complex series of staggered timeframes for admission to state-run, inpatient treatment... [allowing] CDHS to prioritize the most acutely ill patients by requiring CDHS to admit them for restoration treatment more quickly.”<sup>19</sup> If the state fails to meet any of these deadlines within a 12-month period, it faces a maximum of \$10 million in fines, which would be used to “enhance community mental health services.”<sup>19</sup> Additionally, the agreement promises to “implement a coordinated wide-scale outpatient community restoration program,” create a team to manage data to make better informed decisions, and increase training and uniformity for competency evaluators and evaluations<sup>19</sup>.

While the agreement sounds hopeful on paper, especially with the mention of a comprehensive reform plan, the families of mental health patients suffering in the system know all too well that a huge gap exists between claims of action and finally delivering those promises. For years, these previous lawsuits have led to the state’s assurance that changes will be made to the system and, for years, mental health patients and their families have been let down by the state’s failures. Path dependency has resulted in the state doing the bare minimum to

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meet terms of various agreements for short-term, immediate fixes after lawsuits and sanctions force the state's hand. Lasting reform, however, requires a much more extensive evaluation of how mental health patients receive treatment and how they are addressed within the criminal justice system. Hopefully, this newest plan can initiate lasting reform, but the last decade suggests that will not be the case.

### 4 CONCLUSION

A long history exists of the failed reforms and continual efforts of DLC to create lasting change in the way the state treats detainees who suffer from mental illness. As presented in the research, it is clear that the CDHS and CMHIP have, in the past, refused to change their methods and instead only try to escape impending penalties and lawsuits when they arise.

Ultimately, the situation in Colorado is not unique; it represents a broader failure of the criminal justice system, which remains rooted in old procedures and mindsets instead of welcoming the possibility of reform. Scholar Katherine Beckett refers to this path dependency as "the tendency for courses of political or social development to 'generate self-reinforcing processes' that frustrate efforts to change direction."<sup>20</sup> One of these self-reinforcing processes in Colorado's case is the state's automatic filling of additional hospital beds, without ever addressing the underlying problem producing the backlog. When they open more beds under the assumption that it will fix the issue, they neglect to consider the lack of staffing and other resources that are also necessary, which only contributes to the problem.

Another example of a positive feedback mechanism in Colorado is when the courts order excessive inpatient restoration in the first place. As the research outlines at the beginning of this paper, the process to determine competency is complicated, but it is also the method that has been used for years. If courts started to reconsider who really requires state mandated inpatient restorative treatment and instead examine who would benefit from outpatient treatment, the numbers of detainees waiting for admittance to CMHIP would decrease. However, the state has only ever reacted to mental health service in one way, and to change it comprehensively, as the Special Master and DLC suggest, would be very difficult. Too much history, money, and too many resources have been devoted to the system as it currently exists, and path dependence stands in the way of reform.

Furthermore, Colorado's situation exacerbates Beckett's concept of the carceral state<sup>20</sup>. When these detainees are locked in jail for excessive amounts of time, they not only experience adverse effects on their mental health, but they are also cut off from society. The longer they wait in jail for evaluations or treatment, the

more detached they become from a normal, functioning, anti-crime life. Their involvement in the carceral state reduces their chances of success and reintegration into society after receiving the restoration treatment they need. This is why DLC advocates for more community-based treatment services, which would allow offenders to interact with their families and sometimes even keep their jobs, rather than the inpatient forensic mental health hospital at CMHIP. Unfortunately, creating these community services requires even more resources that the state does not possess. However, if the state developed a new mindset open to changing the traditional pathways to restoration, they could consider reallocating funds dedicated to building more units at CMHIP that are focused on new outpatient treatment programs instead.

There are a few negative feedback loops present in the case of Colorado, and, as Beckett explains these mechanisms, they might provide some hope for lasting reform<sup>20</sup>. One of these negative feedback loops is discussed thoroughly in Hadar Aviram's book *Cheap on Crime*. The impending fiscal costs of a broken system, especially after the 2008 recession, have left many states forced to make reforms for the sole purpose of saving money<sup>21</sup>. For Colorado, the fiscal disadvantages are evident in local sheriff departments and county jails, where it costs substantially more to detain mental health patients than other detainees. Costs are also high to maintain CMHIP, which caused the understaffing that contributed to the backlogs in the first place. Furthermore, the state faces many sanctions for the various lawsuits and decrees that are designed to compel the state to fix the issues. Even with these negative feedback loops, however, costs have not deterred the state in the past, and path dependency suggests that costs will not incite reform in the future, either.

### 5 FURTHER DIRECTIONS

If Colorado hopes to create consistent and lasting reform, it must approach mental health and the criminal justice system in a broader way, addressing all aspects of the system rather than focusing on minor changes designed to mitigate consequences of past mistakes. The focus needs to be placed on revising mental health institutions as a whole, starting by creating more community-based programs, as opposed to just complying with the Settlement Agreement. This mirrors Christopher Seeds' discussion of recent criminal justice reforms and how they require a comprehensive plan<sup>9</sup>. This "comprehensive approach" to reform requires participation from all parties involved, bipartisan support in government, empirical evidence, and a mindset ready to finally abandon path dependency. This would include judges who, rather than sending all mentally ill detainees to CMHIP by default, would use

discretion to determine which low-level offenders could be directed towards outpatient treatment instead. This comprehensive approach would also involve funds being directed towards creating outpatient services rather than being funneled back into building more beds at CMHIP. Only then can Colorado—and the criminal justice system as a whole—hope to improve the lives of those involved in the carceral state and establish meaningful reform. Future research should not only address the most recent activity regarding the lawsuits against the state of Colorado, but it should also study the actions taken by lawmakers and other advocacy groups like DLC to initiate reform. It is important to ask which reforms, if any, have been successful and why. It is arguably more imperative to ask which reforms have failed, why they failed, and what actions can be taken differently in the future in order to be successful.

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## 7 EDITOR'S NOTES

This article was peer reviewed.

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# Establishment of the Classical Saxophone: The evolution of instrumental design and performance into the 20<sup>th</sup> century

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## Abstract

The instrumental design of the saxophone has evolved dramatically from its original patent in 1846. Referencing instruments from the St. Cecilia's Hall Music Museum at the University of Edinburgh, this article explores the historical origins of the saxophone and traces the evolution of its design into the 20th century. Original research was completed through analysis of unique antique saxophones at St. Cecilia's Hall and historical source materials in order to determine how, despite its intention to be used as a classical instrument, many factors such as politics, instrument structure, finances, and musician attitude at the time of the saxophone's invention resulted in limited classical saxophone performance in the modern day. This article addresses the importance of exploring the early history of instruments as an aspect of contemporary musical study.

**Keywords:** saxophone – Adolphe Sax – performance practice – instrument design – music history

## 1 INTRODUCTION

First officially patented in 1846, the saxophone is the most recently invented Western instrument that is written with frequency into modern orchestral and wind ensemble compositions. Due to its relative novelty, as it was not invented until the Romantic period of music, the amount of repertoire existing for solo and ensemble classical saxophone compared to most traditional instruments is limited. In addition, the popularity of saxophone in jazz and rock overshadows its origin and usage as a classical instrument. Despite its lack of extensive recognition, the repertoire and schools of classical saxophone study are still vital to historical understanding of the instrument and remain a versatile area of musical performance. This article contains original research on the complexity of the evolution of saxophone design since Adolphe Sax's initial patent and will focus on the progression of alterations to the alto saxophone that allow for the virtuosity of performance that classical saxophone repertoire requires today. The progression of saxophone design will be traced through unique historical instruments from St. Cecilia's hall. In addition, this article will explore the causes of diminished popularity of the saxophone as a classical instrument from a historical perspective. This analysis of causes for the low prevalence of classical saxophone will include original research forming connections between

instrumental design with historical factors.

## 2 THE ORIGINAL SAX PATENTS

Adolphe Sax initially invented the saxophone as a melodic low woodwind that could imitate the timbre of orchestral strings but had the volume of brass instruments. In the original patent, Sax states that "the character of [the saxophone's] voice can be reconciled with the stringed instruments, but which possesses more force and intensity than the strings"<sup>1</sup>. The bassoon and the bass clarinet (which Sax himself had invented in 1838) were both too quiet for large concert settings, especially outdoors, and low brass instruments lacked the consistency of tone and technology to play quick melodic passages<sup>2</sup>. One popular theory behind Sax's inspiration for the saxophone was that he combined his work optimizing the bass clarinet with the work of his father. Charles-Joseph Sax had the title as the "Musical Instrument Maker of the King of Brussels" and spent the majority of his efforts designing ophicleides<sup>2</sup>. Until the invention of the saxophone, the ophicleide attempted to fill the gap, but was not ideal as it lacked a functional lower range, stood out from the rest of the orchestral sound, and maintained poor intonation.

There has been some confusion when observing the original Sax patents about which instruments had ac-

tually been finalized and physically realized as part of Sax's saxophone family. The 1846 patent, seen in Figure 1, shows eight total saxophone models, but only *no.1* and *no.2* in the diagram have any detail in design. This would imply that the very first saxophones that Adolphe Sax actually created were the E $\flat$  baritone saxophone (*no.1*) and the C/B $\flat$  bass saxophone (*no.2*)<sup>3</sup>.

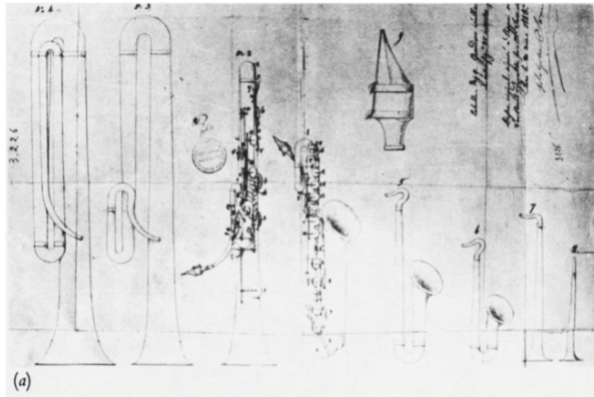


Figure 1. Adolphe Sax's original 1846 saxophone family patent<sup>3</sup>

These initial patented models gained massive popularity in the French military band, which required the volume and dexterity that Sax provided, but the man was shortly to fall on hard times. Sax's rivals claimed that there was too much similarity between the saxophone and the ophicleide, especially since the original bass saxophone still retained the ophicleide shape. Along with being drawn into lawsuits against competitors designing their own types of "saxophones", Sax lost his foothold in the French military band as King Louis Philippe, who's favor he had gained, was deposed in 1848, and saxophones were removed from the standard instrumentation<sup>2,4</sup>. Although fiscally devastating, this period of misfortune allowed Sax the time to develop his designs. He attempted to move the saxophone even further from the ophicleide by adjusting the position in which saxophones were held and spent time expanding upon and finalizing the different members of his saxophone family. In Figure 2, his 1850 Belgium patent shows a four-part saxophone family that is recognizable today: *no.1* – B $\flat$  soprano saxophone, *no.2* – E $\flat$  alto saxophone, *no.3* – B $\flat$  tenor saxophone, and *no.4* – E $\flat$  baritone saxophone<sup>3</sup>. This patent also contained designs for an E $\flat$  soprano and a C bass saxophone<sup>2</sup>. By utilizing the resources at the instrument museum at St. Cecilia's Hall at the University of Edinburgh, the earliest model alto saxophone I was able to observe was an 1856 Adolphe Sax alto, and this allowed me to document differences between Sax's original conception of the alto saxophone in comparison to subsequent designs.

Sax's original design is by no means a simple instrument. He was extremely interested in acoustic efficiency,

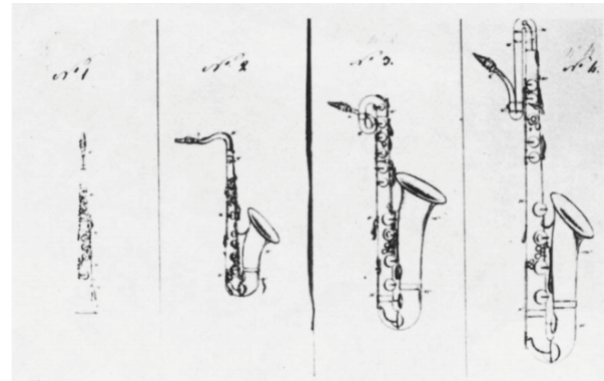


Figure 2. Adolphe Sax's 1850 saxophone family patent<sup>3</sup>

which can be observed in the carefully constructed bore of the saxophone. Both the bassoon and oboe also have conical bores, but Sax's design was unique as the changing diameter of the saxophone is not consistent but rather parabolic in order to maximize the reflection of soundwaves within the instrument. By including three other smaller parabolic curves within the body of the instrument, Sax was able to most efficiently project the volume of the saxophone while creating its unique bright and sonorous timbre<sup>1</sup>. He also claimed that this parabolic shape allowed the saxophone to be "able to change the volume of its sounds better than any other instrument"<sup>1</sup>. The original key system, although not as layered as modern saxophone key systems, was inspired by the latest in instrumental technology: the Boehm flute. Theobald Boehm created a key system in 1832 that placed large-bore tone holes in their most acoustically accurate locations on the instrument, using pivoting rods to mechanize keys together<sup>2,5</sup>. This made more ergonomic sense for performers as they were able to press a key that was within easy reach to open or close the actual tone hole from a distance. By utilizing Boehm's key system, Sax was able to create his saxophone with more accurate intonation throughout its length and allow for more dexterity of playing compared to the ophicleide, for example, which had a separate lever for each key<sup>2</sup>. The acoustics of Sax's original design may have favored the lower register of the saxophone, sacrificing higher harmonies due to minor misalignments of tone holes compared to modern saxophones<sup>2</sup>. This is likely due to its initial conception as a low register woodwind. Compared to the virtuosity that modern saxophonists tend to emphasize for the higher registers of the saxophone, early saxophone performance and compositions likely preferred the lower registers due to intended usage and instrumental design.

Once composers realized that the saxophone could perform parts written for its middle and upper registers with a more pleasing acoustic result, instrumental de-

## Establishment of the Classical Saxophone

sign began to shift to allow for clearer high harmonies. By the turn of the century, compositions for this instrument were able to be more complex and more interesting to both perform and listen to as fast passages are significantly easier to play on the higher registers of a saxophone.

### 3 EARLY USAGE OF THE SAXOPHONE

Initially finding its place in French military music, the range of early saxophone repertoire was small and mostly written by personal friends and acquaintances of Sax. Hector Berlioz was one of the first and most avid advocates for Sax's new instrument family, providing the material for the saxophone's first public performance in 1844<sup>2</sup>. Adolphe Sax himself played the bass saxophone for Berlioz's *Chant Sacré* orchestrated as a "Hymne pour les instruments de Sax", and this initial performance was praised as "a victory gained by Mr. Sax" by composer George Kastner<sup>2</sup>. Kastner proceeded to include the bass saxophone in his opera *The Last King of Juda* later that year, claiming to have written the first orchestral setting for saxophone. The first saxophone method book, *Complete and Systematic Method for the Saxophone*, was written in 1846 by Kastner, who was now one of the saxophone's most vocal supporters<sup>2</sup>. Early performances of compositions such as *Chant Sacré* and *The Last King of Juda* confirm that Sax initially intended for the saxophone to remain a bass voice blending with the rest of the orchestra. This is very different from the modern use of saxophones as a melodic, soloistic instrument.

Instruction in saxophone performance began shortly after its 1850 redesign and subsequent growth in popularity as Adolphe Sax himself was instated as a professor at the Paris Conservatory in 1857<sup>1</sup>. As Sax realized the soloistic potential of his instruments, he wished to increase the amount of repertoire available to his students and created a publishing house for new saxophone works in the 1850s<sup>1</sup>. Prominent composers rose to the occasion, the most well-known being Joseph Arban, Jules Demerssen, Hyacinthe Klosé, and Jean-Baptiste Singleleé<sup>6</sup>. Works by these composers are still occasionally played today, but do not make up the majority of a modern classical saxophonist's repertoire. These early works are relatively limited in range and complexity compared to later saxophone compositions, and this has been attributed to the small number of passionately virtuosic early saxophonists. Due to its novelty, the saxophone was often seen as something that could be quickly learned as a secondary instrument and few, outside the Conservatory, took the time to become proficient. Thus, early composers would still include saxophone in their works, but almost always wrote out doubled parts in different instruments in case an adequate player could not be found<sup>6</sup>.

Another reason that may have limited the growth of the saxophone into the orchestral realm was that early composers would tend to write parts for the saxophone in primarily its lowest register and at very soft dynamics<sup>6</sup>. Due to the instrument's conical shape, it is significantly harder to play quiet low notes than in the middle or high registers. This differs from the ease of playing low notes on straight bore woodwinds such as the clarinet, and likely dissuaded early composers and players alike from taking the saxophone more seriously as a classical instrument.

### 4 EVOLUTION OF DESIGN

As the alto saxophone slowly grew in popularity as a solo instrument as more people learned about it, the design of the instrument changed to accommodate quicker passages, provide an increased range, and improve tone at the higher end of the instrument. Between the 1856 and 1869 Adolphe Sax alto saxophones I viewed at St. Cecilia's, the diameter of the bore of the instrument was decreased both distally and proximally. Sax had continued to decrease the size of the bell relatively consistently throughout his production of instruments, and this change from the original patent continued. Difference in bore and bell size can be observed in Figure 3, through comparison between the bell of a modern saxophone, such as my own 21st century 991 Yanagisawa alto, and the 1856 Adolphe Sax alto. The reason behind this change is that less material is used when building a smaller bell, and it is less likely to be damaged<sup>2</sup>.



Figure 3. Bell and bore size comparison between modern 991 Yanagisawa alto (above) and 1856 Adolphe Sax alto (below)

Once Sax's final saxophone patent expired in 1866, other companies were able to build upon his original design and add many of the different features that modern saxophones still maintain today<sup>1</sup>. The ability for competitive invention upon this instrument, allowed

by the patent expiration, drove new innovation in the design of the saxophone. The distinct dual-octave key system that allowed separate venting for the upper and lower register of the octave was changed into a single key mechanism that would automatically change the venting by the end of the 19th century. This difference can be observed when comparing the 1856 and 1869 Adolphe Sax models, Figure 4. and Figure 5. respectively, with the 1901 Evette & Schaeffer (which shortly became Buffet Crampon) model in Figure 9. The single octave key mechanism allows significantly more dexterity when playing as the left thumb does not have to shift keys depending on the location of notes in a passage, but this can also cause some issues as both of the tone holes of the octave key have more tendency to stick in a single key mechanism.



Figure 4. 1856 Adolphe Sax alto dual-octave key system

Another dramatic change that occurred at this time is that some manufacturers altered the original multiple parabolic bore system that made Sax's patent so unique, rather conforming to a standard conical change in bore diameter<sup>1</sup>. This consistent conical bore is used in most modern saxophones and indicates that today's saxophone sound has a different timbre than original Adolphe Sax instruments would have produced<sup>1</sup>. Other alterations that occurred entering the 20th century include the addition of the bis-B $\flat$  key, the front F key, the side F $\sharp$  key, and rollers between the keys at both pinkies (see supplemental figures for examples of such additions). These changes all allow for greater ease in quick soloistic passages and smoother movement through chromatic runs that became more and more prevalent in classical saxophone compositions. Other adjustments in body and mouthpiece design also allowed for an expanded high altissimo register which quickly became a



Figure 5. 1869 Adolphe Sax alto dual-octave key system



Figure 6. 1901 Evette & Schaeffer (Buffet Crampon) alto single octave key mechanism

standard of proficiency in saxophone performance.

## 5 CONCLUSION

By observing various unique models of alto saxophones beginning at the year of the instrument's conception to the early 20th century, I observed and traced numerous marked changes that the saxophone has undergone to become the models of instrument recognizable today. Despite the complexity of later saxophone models, the high standard of intention, experimentation, and execution of instrumental design becomes apparent in Adolphe Sax's early patents as well. Early in the sax-

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ophone's history, I was able to research how the interactions between instrument design, assumption of instrument capability and usage, availability of passionate, virtuosic saxophonists, and the resulting characteristics of 19th century compositions for saxophone all play a role in the relatively small area of classical saxophone study today. Although few original Adolphe Sax instruments remain in playable condition, alterations in design that impact size, keys, and weight of the instrument indicate that compositions played upon early saxophones would sound and feel different than if played upon modern instruments and would require a period of study for modern saxophonists to attempt to replicate what the initial premieres of saxophone performance may have sounded like. Due especially to the change in bore from original Sax models to today's instruments, which dramatically altered the timbre, proficiency on these early saxophones appears necessary to truly recapitulate the experience of early saxophone performance.

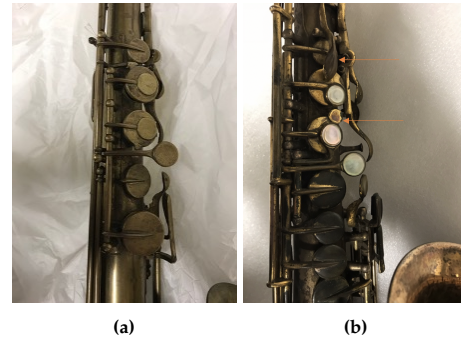
The study of historical instruments is vital to a complete comprehension of contemporary musical performance and academia. The history of an instrument explains modern design, the extent and diversity of repertoire available for such an instrument, the style of ensemble that instruments are commonly placed into, and the cultural context and impact of instrumental innovation. By studying the past, a greater understanding of the present is attained, as well as new appreciation and value of the progress made.

## 6 ACKNOWLEDGEMENTS

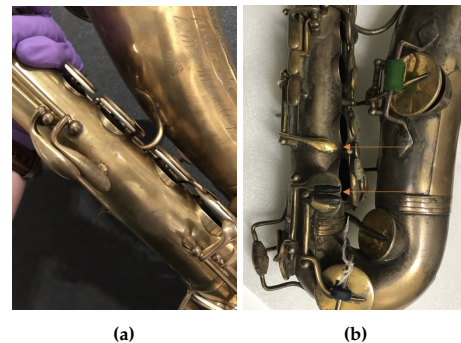
I wish to primarily acknowledge the assistance of Dr. Jenny Nex, curator of the St. Cecilia's Hall Musical Instrument Collection at the University of Edinburgh, as she generously provided a private showcase of the historical saxophone collections available and provided resources to learn more about the individual models. Images not otherwise cited are credited to the author, taken of the St. Cecilia's Hall Musical Instrument Collection at the University of Edinburgh. I also wish to acknowledge the instruction of Dr. John Butt, Professor of Music at the University of Glasgow, in providing the lecture resources and opportunity to write this article in his Performance Practice course. I thank Art Bouton, Professor of Saxophone at the University of Denver, for his encouragement and feedback on this article.

## 7 EDITOR'S NOTES

This article was peer reviewed.



**Figure 7.** Addition of bis-Bb key and front F key. **A** Primary left-hand keys of 1869 Adolphe Sax alto. **B** Primary left-hand keys of 1901 Evette & Schaeffer (Buffet Crampon) alto, highlighting addition of front F (top arrow) and bis Bb keys (bottom arrow)



**Figure 8.** Addition of side F# key. **A** Right-hand side C and Bb keys of 1856 Adolphe Sax alto. **B** Right-hand side keys of 1901 Evette & Schaeffer (Buffet Crampon) alto, highlighting addition of side F# key (top arrow) and rollers between R4 Eb and C keys (bottom arrow)



**Figure 9.** 1901 Evette & Schaeffer (Buffet Crampon) alto single octave key mechanism

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## Faculty Spotlight: Dr. Phil Danielson

Interviewed by Hannah Stanley and William Moody

### 1 WHAT ARE YOUR TEACHING INTERESTS? WHAT IS YOUR TEACHING PHILOSOPHY?

My teaching interest is focused on anything having to do with molecular biology. What interests me in a broad sense, is the use of DNA technology or advanced protein technology. But more specifically, I'm very interested in how these 21st century technologies impact human health. The classes that I teach such as immunology and virology and infectious disease focus a lot on the technologies we use to diagnose and to treat diseases. I also teach a course called human molecular biology that focuses on how we use technology to personalize medical care. I'm very passionate about that part of science, which is the interface between pure science and the elegance of our technologies and how it impacts people in the real world.

One part of my teaching philosophy is that I strongly believe that you should expect and push your students to achieve more than even the students themselves think that they're capable of. It has been my experience that if you push students to achieve more, you'll push them beyond what they think is the limit. When someone believes in you and inspires you, usually you can achieve more than you thought you could.

### 2 WHAT SPARKED YOUR INTEREST IN THE FIELD THAT YOU WORK IN?

I was very fortunate that when I was an undergraduate myself, I had a really incredible professor, Jeanne Bowles. She made science very interesting, approachable, and accessible. So I would say my experience as an undergrad has shaped a lot of my current teaching philosophy. When I think about what a teacher should be, what a teacher should bring to the classroom, and how courses should be structured, I think that courses should be so much more than just memorizing. I think that you have to not only be knowledgeable about what you teach, you have to not only like what you teach, but you have to actually love what you teach. The excitement and passion that you have should be evident to the students who come into your classroom. If you are truly passionate about your field, everyone around you will know. Before I came to the University of Denver, I spent

time teaching at the juvenile prison in Golden, Colorado. That was a tough group of kids but I really enjoyed teaching them about science and finding ways to get them excited about science too.

### 3 HOW DO YOUR INTERESTS IN WHAT YOU TEACH IN THE CLASSROOM CORRELATE TO THE RESEARCH YOU DO?

The classroom is an introduction to a field where students can learn the way that we approach and solve problems. Research is taking the next step in which a student is in an environment where they can solve problems in an open-ended way. In research, you're giving students an opportunity to apply knowledge they learned in the classroom to a real-world problem. In laboratory research, the ultimate answer that you're searching for is not known. This is a surprise to a lot of undergraduate students when they first get to the laboratory because they want to know what answer they're looking for. But the truth is, we don't know what the answer is, and that's the purpose of doing research. I have found this aspect of research to be very exciting for a lot of students because they see that they might be the only person in the world who's looking at this specific problem for the very first time.

### 4 WHAT WOULD YOU CHANGE TO IMPROVE HOW WORK IN YOUR FIELD IS DONE?

When you're the research director of a lab, what you discover very quickly is, especially in molecular biology, research is extraordinarily expensive. Therefore, in order to do research as a professor, a lot of time is spent chasing dollars. I spend a lot of time and effort writing grants and trying to get money to conduct the research. If I could change anything, I would come up with a way of having research funding that didn't require professors to spend so much time chasing after grant money. Most proposals that you write don't get funded. It's a very discouraging activity in some ways. If there were a way for money to be better distributed, or to produce scientific instruments that weren't so expensive, that would be ideal.

## 5 HOW HAS THE PROCESS, OR THE PROFESSION OF RESEARCH CHANGED OVER THE PAST FEW DECADES IN YOUR FIELD?

Over time, the biggest change of molecular biology is that research has become less tedious. Many of the materials such as solutions, chemicals, and proteins, would require that you prepare all of it in the laboratory. There was a lot of monotonous work such as sterilizing and removing contaminants from water. In my field, this aspect has changed a lot in the past 20 years. Nowadays, you don't have to start your week of research by figuring out, how you would make a certain solution. Most chemicals are now bought commercially and they're pre-prepared. As a result of this, I spend more time doing what I call higher level thinking. I now get to spend more time thinking about the science that I'm doing instead of getting all the dishes ready.

## 6 DESCRIBE YOUR CURRENT RESEARCH IN LAYMAN'S TERMS.

My laboratory focuses on the development of new technologies for forensic testing. We've developed new tools that laboratories can use in criminal investigations. There are a couple of major areas that we work on, one area is called the bodily fluid identification. In criminal cases, especially in a sexual assault case, it's important to be able to detect the presence of different body fluids that might indicate that a sexual assault or rape took place. Currently, if a person or a woman is the victim of rape, typically, the woman has about three or four days after the assault to go to the hospital and have samples collected before we no longer have the ability to detect DNA. My laboratory has developed technologies that enable us to very confidently detect the presence of a trace of body fluids, like seminal fluid in a woman, even at eight or nine days after the assault. These new technologies give us a longer window of collecting useful information after a victim reports an assault.

The other area we focus on is the analysis of samples that have very low levels or quantities of DNA. The area that I work on currently is looking at the ability to test gun cartridge cases. In the United States, where guns are very common, recovering cartridge cases from crime scenes, especially with murders and shootings, is pretty common. The problem is that the success rate for analyzing them for DNA is usually about only 5 or 10 percent. My lab has developed new technologies to be able to detect the DNA on bullet cartridge cases, and we're successful 50 to 70 percent of the time. I love this area of research because it's very applicable, and I can see where people will benefit from this which very rewarding to me as a scientist.

## 7 WHAT IS THE MOST FRUSTRATING ACTIVITY IN YOUR DAY TO DAY WORK?

The most frustrating activity for me is writing progress reports. Since research is funded by either the government or by private foundations, it is understandable that the organizations that give money want to know what kind of progress you're making. If you have more than one funding agency, you can find yourself writing progress reports every month. These reports are usually 15 pages or more that describe what we did this month, and what the results were. This is an important part of research, but it takes up so much time that it can be kind of frustrating.

## 8 IF YOU COULD GO BACK IN TIME AND GIVE YOURSELF ADVICE BEFORE YOU BEGAN YOUR CAREER WHAT WOULD IT BE?

I am very fortunate that I love what I do. When people ask me what I love about my job, I tell them that I get paid to play. But, if I were to give myself some advice, it would be to spend some more time not working. There are lot of other great things to do in life other than work, and so I would say to take some more personal time. Overall, I am very happy with where I'm at in life.

## 9 WHAT ARE YOUR THOUGHTS ON CORONAVIRUS? HOW HAS IT BEEN AFFECTING YOU?

At the University of Denver, it has affected all of us and the biggest change is teaching via Zoom. That's been a challenge for me because I love teaching and interacting with my students. While we can do that via Zoom, it's definitely more challenging. I have been trying very hard to find a way that I can interact with my students and create that sense that, even though we're all in different places, we're all together.

Something that I have told everybody about Coronavirus is that there is so much misinformation. On the Internet, and even on the news, there is information which is incomplete or might give people the wrong impression. I've told people that this is clearly the most serious pandemic I've seen in my lifetime. But, having said that, it's important to put it in perspective. The Coronavirus pandemic is much worse than the seasonal flu. But, it's not as bad as the 1918 Spanish flu that killed tens of millions of people around the world. I always told my students Coronavirus is not the zombie apocalypse. I'll send an email out when a zombie apocalypse happens. It's important to remember that we are going to get through this. We have to keep a level head and take reasonable precautions. Social distancing and

*Phil Danielson*

hand washing are both really great things to be doing. While the chance of death is very very small for people in younger age groups, it is important to maintain precautions because there are other people that are at higher risk.

I don't think that when this is over that we're going to quickly return to the old normal. After coronavirus, I think things will change. I think people will think twice before shaking someone else's hands or hugging, and this will change how we as humans interact with each other. I think it will change universities as well and how we teach. I think in the university's case, things are going to be better. This has encouraged faculty to figure out how all these technologies work, which for some of them this was all new. I think this is going to be an improvement for those faculty who embrace these new technologies.

## Faculty Spotlight: Dr. Seth Masket

Interviewed by Owen McKessy and William Moody



### 1 WHAT ARE YOUR TEACHING INTERESTS? WHAT IS YOUR TEACHING PHILOSOPHY?

I do a lot of stuff within American politics, but my main interest is in political parties. I'm teaching a senior class right now that just focuses on presidential party nominations, but I teach campaigns, elections, and a party's class. I also teach a class that's a lot of fun called Simulation of American Governments, where each person plays a current member of Congress.

For me, in terms of teaching philosophy, I have found that lecturing at students is not very good teaching. If needed, I'm going to try and provide some history about things that have gone on in the past, but for the most part, I want it to be as participatory as possible to give students a sense of some of the things that I find exciting about the topics. It is largely about getting into why these things are questions, why these things are things we should care about, and to sort of dig into current issues in American politics and trying get some

of their passions for the topic. Many are aware that there is plenty of divisiveness and passion within politics right now. I'm not necessarily looking for people to start yelling at each other, but I just want to direct some of that passion and interest into basic questions about politics and why they exist.

### 2 HOW HAS THE PROCESS OF RESEARCH CHANGED IN THE PAST FEW DECADES IN YOUR FIELD?

It's changed in a number of ways, one of the big ones is the availability of data. 20 years ago, I was working on my dissertation research where I was focused on partisan behavior in California. I was digging up roll call votes cast by every state legislator in California history. That took several years to do. I had to get a grant for that, and there were several computer experts I was consulting with. It was a major project. Today, that information is just simply widely available to anyone who wants it. Researchers don't have to dig into it that way anymore. So, it's interesting in many ways, quantitative data has come easier to come by for a lot of scholars, but what to do with it is always a bigger mystery. It's easy to just dig up a bunch of numbers and find correlations between things, but it's difficult to actually understand the meaning behind them.

### 3 CAN YOU DESCRIBE YOUR CURRENT RESEARCH IN TERMS THAT EVERYONE WOULD UNDERSTAND?

I am just in the process of finishing a book that is on the Democratic Party between 2016 and 2020. I was interested in following a political party across an entire election cycle. I've been spending a ton of time interviewing insiders and party activists in some of the early contest states like New Hampshire, Iowa, South Carolina, Nevada, and DC. I wanted to get a sense of how people within the party were interpreting why they lost in 2016, and then what they do with that information. What I'm arguing is essentially that the Joe Biden nomination didn't just happen for no reason. While it wasn't necessarily obvious that it was going to

be him, there were a lot of the interpretations coming out of that election that the party may have moved too far toward diversity and inclusiveness. A number of people were thinking the party needs to scale back commitment in order to win an election. They were willing to surrender a fair number of their commitments in order to get a win. Even if it hadn't been for Biden, it would have been something along those lines. The party was leaning in the direction of a relatively moderate white guy.

#### **4 WHAT WOULD YOU CHANGE TO IMPROVE HOW WORK IN YOUR FIELD IS DONE?**

There's a style I like to practice when I research that is a combination of qualitative and quantitative work. So, I have a fair number of interviews that I've been doing for this book, and I find those really helpful. I think it's useful to understand how people within what you're studying are thinking and what kind of language they're using to describe it. I think it's also important to have good quantitative data about what's going on to be able to examine, as I do in my book, things like campaign finance patterns or shifts in polling or endorsement patterns. I would like to see more of the discipline moving in a way that really tries to use both. I think if you're just focused on the numbers, you can miss some important understanding about the way the political universe works. I think if you're just using interviews, you can be led astray by people who don't necessarily understand themselves what they're doing, so I think it takes a combination of approaches.

#### **5 CAN YOU SHARE A TURNING POINT OR A TIME YOU MADE A SURPRISING DISCOVERY?**

One thing that was really interesting was when I attended the summer meeting of the Democratic National Committee in 2018 in Chicago. This is not the big party convention with delegates, this is just DNC members. They were arguing through some reform movements about super delegates, and I had been following the debates that they've been having. I knew they were going to make some final decisions about this, so I was just interested in listening to what kind of language people use when they argued. I was so fascinated to hear how raw and emotional people were about these decisions. Very sharp, harsh language along racial lines was used by some African American leaders like, "anyone who supports this measure is basically like a slave supporting the Confederacy." I was shocked to hear stuff that was that raw, but it made me think, I'm researching a real thing here. It gave me some confidence that I was onto something important and it was worth bringing this

stuff to light.

#### **6 WHAT MAKES YOU GET UP IN THE MORNING AND WHAT DO YOU REALLY LOVE ABOUT WHAT YOU DO?**

What gets me out of bed in the morning is sometimes also the thing that keeps me up at night. I have the privilege of studying American politics at a really interesting time. It's not a quiet time in American politics, there are really dramatic and foundational things shifting all the time. It's a little terrifying, and it's not always very positive, but this is the stuff I'm interested in. Since Trump got into office, I've heard a number of people who are not political scientists talk to their political scientist friend and say, "Hey, it must be an interesting time to be studying politics." The usual rejoinder is, "it's sort of like being a doctor during a viral outbreak." Yeah, you're using your training and your skill. It's also a little scary, you don't know what's going to happen next, and a lot of things are being stretched to the limits. I'm studying things that are very, very alive right now, and I like that aspect of it.

#### **7 WHAT DO YOU LIKE TO DO WHEN YOU'RE NOT WORKING ON RESEARCH?**

I like to bake breads, cookies, and I decorate cakes. My go-to baked good would either be white chocolate chip oatmeal cookies or molasses spice cookies. Those tend to be crowd pleasers.

#### **8 DESCRIBE YOUR CAREER TRAJECTORY AND ANY KIND OF ZIGZAGS OR CHANGES THAT YOU HAD.**

I did not go straight into grad school when I finished college. I graduated from UC Berkeley in 1991, and I wanted to go work in Washington DC for a while after that, which I did. I worked for a little bit on the Clinton-Gore campaign in '92. Then I got a job in the Clinton White House from '93 to '96 in the correspondence office, writing letters, presidential messages, and proclamations. I absolutely loved that job and it was a great place to work and a great time to be there. My then fiancé, now wife, got into a master's program at Stanford, so we went to Northern California. There I worked in the local government for the county supervisor for most of the year and I learned a lot from that experience. I started grad school after that at UCLA and came to DU straight from there. I've lived in a number of different places, but that experience working in politics still informs a lot of the things I do. I still think back a lot on that time and

*Seth Masket*

just have some sense of the incentives of campaigners, office holders, and candidates. I just really value that time..

**9 WAS THERE EVER AN OUTCOME IN YOUR RESEARCH THAT WAS UNEXPECTED, OR DO YOU EVER ENCOUNTER LIKE A SURPRISING SETBACK? AND IF SO, HOW DID YOU REACT AND KIND OF ADAPT?**

One of the ways is on this book project that I'm working on now. I had originally proposed to a publisher back in 2016, and my expectation at that time was that Donald Trump was going to lose the presidency. I wanted to spend the next few years interviewing Republicans as they figured out where their party went wrong, and how to change it because it was a really unusual nomination they went through. I wanted to study them as they figured out that they blew a winnable election, and I wanted to see how they would make changes in the party. Obviously, the fall election really threw a lot of people over, so my first instinct after that was okay, well, this book idea is dead. Not long after that, I came to this idea as I'm trying to figure out what went wrong. That's roughly what everyone else is doing too. I'm not the only one on this, and it would be interesting, not just for me to talk about how I got it wrong, but to understand why so many other people did too. So, I kind of leaned into my own error on this and wanted to understand how everyone else had come to the same incorrect conclusion as well.

**10 SO IN YOUR KIND OF DAY TO DAY WORK, IS THERE ANY ONE PARTICULAR THING THAT YOU FIND THE MOST FRUSTRATING?**

I hate grading, but I really enjoy teaching. that's just the mundane part of it that everyone has to do. I know, students don't like being graded, and I don't like administering grades. I would rather just have conversations with them about what they're learning about the reading material and read their writing. Grading is just of the necessary evils to the job.

**11 IF YOU COULD GO BACK IN TIME AND GIVE YOURSELF ADVICE BEFORE YOU BEGAN YOUR CAREER. WHAT WOULD THAT BE?**

I would say make sure you are serious about the subject you want to research. I had talked about this with some advisors in school early on, but there are benefits and cost depending on what you want to study. There are some who believe that you should study what you care

about and that's how you do good research. If you're writing a dissertation, you're going to be working on that for four years, five years, maybe longer, so it should be something you care about. On the other hand, you also want to think about what is it that someone else will want to read. What is it that someone else will want to have in their department someday when they're looking to hire you. I think I probably made the right call with my subject, but it's something additional to think about when you're getting started in this line of work. You need to think of the blend between what you care about and what you think other people will care about.

**12 FOR PEOPLE INTERESTED IN YOUR BOOK WHERE CAN THEY FIND THAT?**

I have a draft of it that is in production right now. It's supposed to come out in September from Cambridge Press, and it's called Learning From Loss: the Democrats 2016 to 2020.

The Veteran's Legacy Program is a research project put on by the National Cemetery Administration, a department of the Veteran's Administration, where undergraduate history departments work with the VA to write unique biographies of individuals buried at national military cemeteries. The University of Denver's history department was chosen to be a partner school starting in the summer of 2018. History department professors Elizabeth Escobedo and Carol Helstosky, along with anthropology professor Esteban Gómez, have run the project since then. While the program is through the history department, students from all majors are welcome to apply to write biographies about the veterans buried at Fort Logan National Cemetery in Denver, Colorado.

As a student who has been a part of the VLP since the beginning, I have loved watching it grow. Writing biographies of veterans has taught me more about the past than any book and made me a better person. I seem to fall in love with every person I research and writing down their lives brings me so much happiness. The VLP sparked my interest in the Vietnam War and the women who served in it, ultimately leading me to what I want to study for the rest of my academic career. The Veteran's Legacy Program is a special project because it humanizes the plain white headstones that line the rolling hills of Fort Logan National Cemetery and does not allow the memory of those who served the United States die. The selected biographies were written by two experienced history majors who have spent two summers working on the VLP. I hope that these biographies encourage all readers to visit our website ([morethanaheadstone.org](http://morethanaheadstone.org)) and visit their local national military cemetery.

Sincerely,  
Chloe Allison  
Senior Humanities Editor

# Touching Hearts in both Life and Death: Brett Lee Lundstrom

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## Abstract

The following article is a product of the Veteran's Legacy Program, a collaboration between the Veteran's Association and undergraduate history departments. Undergraduate history students at the University of Denver began writing biographies about the veterans buried at Fort Logan National Cemetery in Denver, Colorado.

A marine from South Dakota, Brett Lee Lundstrom touched many people throughout his lifetime. He was a member of the Oglala Sioux tribe. He served in both Afghanistan and Iraq but spent the majority of his service fighting for Operation Iraqi Freedom. He was killed in Iraq after a sniper opened fire unexpectedly on his company. He was just 22 years old when he died.

Brett Lee Lundstrom was born in Vermillion, South Dakota on June 12, 1983 to his father, Ed Lundstrom, and mother, Doyla Carol (Underbaggage) Lundstrom<sup>1</sup>. His parents were attending the University of South Dakota at the time of his birth<sup>2</sup>. The couple later had a second son named Ed Lundstrom. Both Brett's mother and father were of American Indian descent. His mother, Doyla Lundstrom was from the Pine Ridge Indian Reservation in the southwestern part of South Dakota<sup>3</sup>. His father was from St. Francis, part of the Rosebud Indian Reservation to the east of the Pine Ridge Reservation<sup>3</sup>. At his birth, Brett became an enrolled member of the Oglala Sioux Tribe in South Dakota<sup>3</sup>.

When Brett was two years old, his father graduated from college and went into active duty in the Marine Corps. As a result, Brett and his brother "grew up in the marine corps," as their mother explained<sup>2</sup>. Due to his father's service, the Brett Lundstrom and his family moved around a lot as Brett was growing up<sup>4</sup>. Brett attended many different schools throughout his childhood. His high school years were spent in Virginia. He attended Woodbridge High School in Woodbridge Virginia when he was a freshman<sup>2</sup>. The family later moved to Stafford, Virginia, where Brett attended Brooke Point High School<sup>2</sup>. During his time there, he ran on the track team and was a part of the Business Leaders of America<sup>5</sup>. He loved going to sporting events with friends, especially when it was to see his favorite hockey team,

the Washington Capitals<sup>3</sup>. He also loved to read as he was growing up<sup>2</sup>. Brett graduated in June of 2001<sup>2</sup>.

In the fall, Brett began college at the County College of Morris in Morris, New Jersey<sup>2</sup>. It was there that he joined a Platoon Leaders Class, offered through the Marine Corps. It was because of this class that Brett would be able to graduate college and enter into the Marine Corps as an officer, like his father had done<sup>2</sup>. The Marine Corps Platoon Leaders Course (PLC) was similar to the Reserves Officers Training Corps (ROTC), but geared specifically toward marines. The PLC is a rigorous program in which students are trained in military tasks and tested for their ability to handle the physically demanding work of being a marine<sup>6</sup>.

While Brett was a freshman in the program, the family was stationed about thirty-five miles west of New York City, when the Twin Towers went down in the September 11th terrorist attacks. Brett's mom, Doyla, explained that after the towers went down, Brett started trying to convince her to let him enlist in the marine corps right away<sup>2</sup>. Doyla, not ready for her son to enter into the marines just yet, said she was able to talk him out of it for about three more semesters but, "he was adamant that he wanted to join the Marine Corps."<sup>2</sup>

In January of 2003, when the family moved back to the home they had built in Stafford, Brett enlisted in the Marine Corps. Both the 9/11 attacks and his father's commitment to the marines motivated Brett in this decision<sup>2</sup>. Joining the marines was always part of Brett's plan. Doyla said that Brett and his younger brother would often play marines as children, remembering that they would dress up in their dads' uniform and pretend to be in the military<sup>2</sup>. Their mom explained that she knew they would both eventually join the military, and she was ultimately really proud of Brett when he did<sup>2</sup>. The tradition of military service runs deep in the

Lundstrom family. Brett's maternal grandfather, and all of his brothers, served in Korea. Brett's father, Ed Lundstrom, was a career marine, meaning that he served in the marines throughout his life, and up until retirement<sup>4</sup>. At least twenty years is needed in the armed forces before one can retire<sup>4</sup>. Brett's brother enlisted in the army after high school as well, following in the family footsteps.

Brett was assigned to Echo Company, 2nd Battalion, 6th Marine Regiment, 2nd Marine Division, II Marine Expeditionary Force, Camp Lejeune, N.C. He completed Boot Camp training in Parris Island, South Carolina. His company first spent some time in Afghanistan. They were later sent to Iraq where Brett spent the majority of his service, fighting for Operation Iraqi Freedom. Operation Iraqi Freedom began on March 20, 2003 with airstrikes on Iraqi President Saddam Hussein's Presidential Palace. The Operation was authorized when Hussein was found to be in breach of the U.N. Security Council adopted Resolution 1441 which prohibited the stockpiling of weapons of mass destruction<sup>2</sup>. The United States forces, combined with troops from Great Britain, invaded Iraq and quickly defeated Iraqi forces<sup>7</sup>. Baghdad fell only five weeks after the invasion began<sup>8</sup>. Afterwards, an insurgency of al Qaeda-inspired fighters poured into Iraq and enacted guerilla warfare tactics against US troops and a civil war within Iraq. This marked the second phase of the war, in which a U.S. occupation of Iraq was opposed by this insurgency.



Figure 1. Brett Lee Lundstrom<sup>9</sup>

Brett made a lot of friends in the Marines, and his mom remembered that he really enjoyed that part of serving. The company also spent some time stationed in Okinawa, Japan, which Brett enjoyed<sup>2</sup>. Brett's military occupation code, or MOS, was infantry<sup>2</sup>. Brett's specific job as an infantryman was to carry what is known as the "SAW." This is the squad automatic weapon, a large automatic weapon that weighs 18 pounds<sup>10</sup>. His mom said that carrying the bulky SAW was Brett's least favorite part of serving<sup>2</sup>. Brett called his mom as often as he could while he was overseas<sup>2</sup>.

In Iraq, Brett's company was stationed in a town called Fallujah. The company was there to patrol the streets. On January 7, 2006, Brett was bringing up the rear of his platoon, carrying the SAW, when a sniper opened fire on him and his company<sup>2</sup>. Brett was killed in the attack along with two other men, Lance Cpl. Jerriad P. Jacobs and Lance Cpl. Kyle W. Brown<sup>11</sup>. Brett

had served three years, and was due to come home in April of 2006, with only a year of service to go.

During his time in the service, he was awarded with a purple heart, two Navy Achievement Medals, an Iraq Campaign Medal, an Afghanistan Campaign Medal, the Global War on Terrorism Service Medal and the National Defense Medal<sup>12</sup>. Brett had achieved the rank of corporal.

The mark Brett left, and the amount of people he touched in his life, is clear. In 2015, a support group for military families donated a ten-passenger van to the Oglala Sioux tribe in Brett's name<sup>13</sup>. The van helped veterans living on the Pine Ridge Reservation in South Dakota with transportation to events and appointments. The Brett Lundstrom Scholarship for the Performing Arts was also created in his honor by a theatre teacher at his old high school who was one of the Lundstrom's family friends. She produces a play in his memory every year and all of the proceeds go towards the scholarship<sup>14</sup>. In 2016, 19 students had received scholarships in Lundstrom's name, each worth up to \$800. In Kyle, South Dakota at the Lakota Prairie Ranch Resort, a conference room was named the Brett Lundstrom Room, where a large plaque is kept, honoring Brett's legacy.

Brett is remembered in his obituary as "charismatic, with a kind and generous soul; always humorous with a smile that lit up any room or place he entered."<sup>4</sup> Brett's mom admires his dedication to his country. She said he was always very outgoing, and made friends with everyone, remembering that he "was just a really good kid." He was honest,



Figure 2. Brett Lee Lundstrom<sup>15</sup>

loyal, and "loved his mama."<sup>2</sup> Brett was buried at Fort Logan National Cemetery after a traditional two-night Native American wake on his mother's home reservation in South Dakota, where the family visited often while Brett was growing up. Doyla remembered that every time the family went back to visit, Brett and his brother "were like little celebrities." This love for Brett and the Lundstrom family was evident at his wake where the community gathered to celebrate his life. Brett then had a Catholic funeral in Denver, where he had a lot of family ties and had planned on living after his service<sup>2</sup>. From family visits to Denver while growing up, Brett came to really enjoy the city, and his mom thought it felt right that he be buried at Fort Logan. Brett's bravery and sacrifice for his country, and the impact he had on the lives of his friends and families,

Brett Lee Lundstrom

will forever be honored. Doyla remembers her son lovingly, saying, “He was my angel... he was my real-life angel.”<sup>2</sup>

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# Biography of Frank Trujillo

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## Abstract

The following article is a product of the Veteran's Legacy Program, a collaboration between the Veteran's Association and undergraduate history departments. Undergraduate history students at the University of Denver began writing biographies about the veterans buried at Fort Logan National Cemetery in Denver, Colorado.

## 1 BIOGRAPHY

Frank Trujillo was born August 20, 1948 in La Junta, Colorado. His family worked as farmers and grew fruit<sup>1</sup>. He was born into a large family with ten siblings — being the 7th boy of eight<sup>1</sup>. He attended Swink High School in Swink, Colorado and graduated in 1967<sup>2</sup>. Military service had been a part of the Trujillo family since Frank was young. In fact, six of Frank's brothers would eventually join the military. On his 18th birthday, Frank enlisted in the U.S. Army to fight in the Vietnam War. Four of Frank's brothers had already enlisted in the military by this time, including his older brother Roque Trujillo who also served in the military during the Vietnam War<sup>3</sup>. While it may have been expected of Frank to follow in his brother's footsteps, there were other reasons for his enlistment. Frank wanted to get away from his family environment, writing "I enlisted to run away from my abusive father... and learn responsibility"<sup>1</sup>.

Frank started out with the 101st Airborne Division and was stationed at Fort Campbell, Kentucky<sup>1</sup>. In December of 1967, Frank was shipped out to Vietnam where he worked in the kitchens and in waste disposal which mainly consisted of burning garbage<sup>1</sup>. Frank was on leave in his home town of Swink, Colorado in November, but was a few days late in reporting back to his C.O.<sup>1</sup> As a punishment, Frank was reassigned to Charlie Company which was located on the front lines. When Frank's rotation began and he was about to be called to the front lines, a clerk named Patrick J. Graham pleaded with Frank to swap places<sup>1</sup>. Patrick was from Minnesota and, according to his sister, had always wanted to see combat<sup>4</sup>. He was frustrated with his role in the Army because he felt as if he was not contributing enough as the Headquarters Company Clerk. Frank initially refused Patrick's request to switch positions, but eventually he agreed<sup>1</sup>. Frank then began clerking while Patrick went to the front lines. Unfortunately, two

weeks after Patrick and Frank traded positions Patrick Graham was killed in action. This had a deep impact on Frank as he felt responsible for his death. Later, when Frank began writing poetry he wrote about Patrick and the remorseful feelings he had. Initially, Frank did not acknowledge Patrick's death and tried to avoid thinking about it altogether. Frank accepted what had happened 18 years later and said that he was "pissed off and angry at myself for not acknowledging him and what he did. I keep asking myself... why him and not me?"<sup>1</sup>

On February 20th, 1969 Frank was honorably discharged from the Army, however, the day before he was due to leave, he got into an altercation with a high-ranking officer. Frank and his friends were relaxing off-duty when the officer started to accost them without reason. The conflict became heated and physical between Frank and the officer. Frank then left the base believing that he could be in serious trouble. He stayed the night at a Vietnamese compound where he knew one of the tenants. However, one of Frank's friends informed him that their Sergeant found out the officer had been harassing Frank and chose not to punish him. Frank returned to his hometown of La Junta and worked at the David Owan Airport where he helped to assemble and build campers, he then moved onto the Colorado Fuel & Iron Corporation<sup>5</sup>. Initially, Frank's time in Vietnam continued to affect him as he felt responsible for Patrick's death as well as taking part in a war he did not agree with. According to his wife Darlene, Frank "likely suffered from PTSD... and he did start to drink more heavily"<sup>1</sup>. He destroyed the Bronze Medal that he was awarded in protest and wrote more poetry to express his feelings. In a poem titled *The American Dream*, Frank says "A vision of life that has sent me to the rice paddies of Vietnam. To destroy life. And lives. My life. My lives"<sup>6</sup>. Frank's identity as a Chicano and a farmer conflicted with his involvement in Vietnam. As he spent

more and more time in country, he began to identify more with the farmers in Vietnam who were simply trying to live their lives just like his family in Colorado. Eventually, Frank worked to resolve his guilt and remorse for his time in Vietnam in a very constructive and healthy way. He accomplished this by immersing himself in community projects in Colorado; it was during this time that he met his wife. Frank also stopped drinking and remained sober for 30 years.

Frank met Darlene Trujillo in 1987 at a community organization in Denver called Servicios De La Raza which is focused on “culturally relevant human services”<sup>7</sup>. They were married in 1988<sup>8</sup> and had one daughter together whom they named Yvette. Darlene and Frank were very active in the Denver community, especially at Su Teatro, a theatre and organization that focuses on Latino cultural arts. Frank was an active board member of the theater and eventually worked with others in the community to buy the theatre from the city of Denver. Tony Garcia, the director of Su Teatro and a close friend of Frank, claimed that Frank was always logistically minded which helped him work in real estate. He kept the board members on track and knew how to realistically tackle goals that the program had<sup>8</sup>. Tony Garcia recalled a story that showed how devoted Frank was to his community and to the Su Teatro project when the board was trying to purchase the theatre from the city of Denver. Three of the board members including Frank and Tony “were sitting around the table” deciding if they would put up their homes in order to purchase the theatre. “All three of us said we would... Frank was that determined to make it happen”<sup>8</sup>. Thankfully, the board members never had to go to that extreme to buy the theatre because they received a \$400,000 grant from the Gates foundation. When Tony found out that they had the funding to purchase the theatre, he immediately called Frank. Upon hearing the news, “Frank started to cry”<sup>8</sup>.

Frank was also known to bring in people from around the community to work on Su Teatro. According to Tony Garcia, he would include members based on their talent, but also because they were often troubled. Frank believed that their involvement in Su Teatro would help them with some of their worries and provide them with a positive outlet in life. The theatre undoubtedly aided Frank in his past as well. Frank’s time in the Vietnam War, especially his experience with Patrick Graham, eventually overlapped with his work at Su Teatro. When a performance was held that centered around the Vietnam War, Frank opened the performance with a poem he had written about Patrick Graham and the guilt he still held. Tony Garcia and Darlene Trujillo both remember this as a cathartic moment for Frank.

Unfortunately, soon after the theater was purchased, Frank’s health began to decline. He was talking to his wife Darlene about what would come of his life insur-

ance policy and Frank made sure that a portion of the money would go to Su Teatro when he passed. Frank Trujillo passed away on July 15th, 2010, and the board members all agreed that the black box performance area in Su Teatro would be renamed to the Frank Trujillo Salon De Arte. It is difficult to sum up a person’s personality in any short span of time; however, Tony Garcia comes close when he described who Frank was. “Frank was a real smart, analytical person, but he was a softy. He had an incredibly big heart and he cared very passionately about the well-being of the community”<sup>8</sup>. Frank is survived by his wife Darlene and their daughter Yvette. He is buried at the Fort Logan Cemetery in Colorado.

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