Social Media, Outreach, and Research Campaigns Focused on Hawaiian Sociology and Ecology

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Introduction

Though the United States ranks highly in university-level education (Times Higher Education 2022), the U.S. falls behind in global ranking for K-12 science teaching (Desilver 2017). The national science teaching association (NTSA) state that informal events focused on science education in an out-of-school setting are crucial for promoting scientific learning and thinking for K-12 students (NTSA 2012). Becoming a scientific thinker is a lifelong endeavor and is driven by engagement with scientific materials both within and outside the classroom (NRC 2009).

Environmental education is crucial for the understanding of broad issues such as climate change, which is still widely misinterpreted by the lay public (Tobler *et al* 2012). Educational material based on science delivered by university-level outreach programs can increase the intrinsic motivation of children to learn science, regardless of the delivery method of the material (Weeks and Oseto 2018). We used a three-tiered approach for delivering outreach materials focused on entomological and environmental science.

Methods

Three-tiered methods promote interaction with real scientists and scientific materials, introduce basic topics in an interactive manner, stimulate deeper thought and questioning of basic concepts, and inspire further exploration of science outside the classroom. Due to lack of time, no baseline data were collected to assess the effectiveness of these methods; however, these strategies provide a framework for delivering educational materials for K-12 students in a fun and interactive manner.

As part of Chaminade University's mobile outreach program *I am a Scientist*, we visited xx schools on the island of Oahu, HI and served approximately xx students over the summer of 2022. The programming delivered was focused on entomology but included topics in broad ecology and taxonomy as well. The programming began with a brief explanation of what entomologists are, how they conduct field research, and how to utilize tools that real entomologists use. Students were informed that they would be participating in a real insect collection activity, and were given rules to follow during the activity (I.e., avoiding stinging insects, staying within the sight of the instructors, and respecting the real scientific equipment they will use) Students were provided with real equipment that entomologists employ in field research – scientific-quality insect nets, forceps, hand lenses, and small Petri dishes. Under the guidance of the instructors, students were allowed to explore an outdoor area for approximately 20 minutes to collect any insects they found using the methods previously described by instructors. Students stored insects in the Petri dishes provided and then returned to the classroom.

Social media communication in science is a key outlet that can increase public interaction with real scientists. In the forensic sciences, juries of laypeople directly interact with scientific material, and must critically think about the science presented in a high-stakes environment. Social media communication about the forensic sciences that is presented in an engaging and artistic manner could increase individuals' scientific literacy when interacting with forensic science in a courtroom setting. They may be better prepared to question scientific methods presented by forensic scientists.

Our social media strategies to maximize and generate engaging materials were through an infographic "flipbook" posted on the Chaminade University Forensic science social media accounts. Our communication focused on the history of forensic science, popular fields in forensic science, and common misconceptions proliferating the public sphere. In creating infographics, we focused on attempting to anticipate frequent questions asked when reading the infographic and structured information flow based on anticipated questions. Throughout summer 2022, our Instagram and

Facebook pages increased by approximately 150%. Of the top 10 posts on our Instagram page, eight were about the infographics. Facebook and Instagram engagement has remained steady after concluding our infographic campaign.

Findings

"Corpse flowers" are plants from a variety of families which utilize internal organic reactions to emit volatile organic compound (VOC) signals. It is known that *Calliphoridae* and *Sarcophagidae* are sensitive to VOCs and utilize VOCs to locate vertebrate carrion, which they utilize as resources for their progeny. Corpse flowers such as *Stapelia gigantea* have been observed attracting various species of necrophagous insects (I.e., *Calliphoridae, Sarcophagidae*). Necrophagous insects function as pollinators for the corpse flower, but do not directly benefit from visiting the flower. Thus, corpse flowers negatively impact the success of the flies via deceptive cues.

VOC profiles for the largest species of corpse flower, *Amorphophallus titanum,* have been previously determined via gas chromatography coupled with mass spectrometry. However, the VOC profiles generated from a smaller species of corpse flower, *Stapelia gigantea*, is unknown. Though *A. titanum* and *S. gigantea* are taxonomically distant, they both produce VOCs which attract various species of insects. The mechanism for VOC production between these taxonomically distant species is unknown, and the ultimate difference in the levels and composition of VOCs produced by these species is unknown. Additionally, the variability of species composition for the necrophagous pollinators attracted to these two plants is unknown.

Understanding the VOC composition and insects present at *S gigantea* can reveal physiological differences between corpse flowers that are taxonomically distant. Since corpse flowers emit complex VOC profiles, they could be used as a more accessible and tunable (based on plant species) proxy for studying insect attraction to carrion as opposed to using vertebrate carrion, which is more difficult to obtain and produces more variable VOC profiles based on body composition.

Conclusions

We present methods for efficient collection of VOC profiles from *S. gigantea* using thermal desorption or solid phase microextraction with static or dynamic collection methods. Additionally, we propose the analysis of these compounds via GCxGC-MS. Utilizing GCxGC as opposed to singular GC provides sample separation with a higher resolution and can allow for the analysis of more complex mixtures of gaseous analytes. The methods we propose can be applied to a wide variety of corpse flowers across the pylogenetic tree and will enable the further study of these plants to probe their ecological function.

Assessing methodologies for volatile compound collection from the corpse flower *Stapelia gigantea* using thermal desorption and solid-phase microextraction.

Introduction:
Stapelia gigantea (N.E.Br) is a succulent in the family *Apocynaceae* considered to be an invasive species in Hawaii [1]. *Stapelia gigantea* is a type of "corpse flower", which utilizes scent, color, moisture, and temperature to emulate vertebrate carrion in order to attract necrophagous (i.e., carrion-feeding) arthropods to facilitate their pollination [2]. *Stapelia gigantea* and other corpse flowers (most famously *Amorphophallus titanum* (Becc.)) release metabolic volatile organic compounds (VOCs)(i.e., scents) [3]. These VOC profiles have been found to attract flies such as Muscidae, Calliphoridae, and Sarcophagidae [4,5].

Objectives: Though *S. gigantea* and *A. titanum* employ similar strategies to attract pollinators, they are taxonomically distant. There have been no dedicated studies on the composition of volatile organic compounds generated by *S. gigantea* in the wild. Assessing the VOC profiles produced by *S. gigantea* and the types of arthropods that attend this species can reveal aspects of their physiology and potential impact on local arthropod communities, as well as the specificity of VOC profiles required for arthropod attraction.

Methods/Findings: We propose methods for the collection of VOCs generated by *S. gigantea* using thermal desorption (TD) and solid-phase microextraction (SPME) in both a passive and active manner. Briefly, we utilized TD columns both with and without a pumping system directly over target flowers. We also used TD columns with pumping after allowing volatiles to accumulate in an overturned container housing the target flower. We performed passive SPME by resting absorbent gauze directly on each flower, and executed active SPME by rubbing absorbent gauze over the entire area of each flower. In addition to sampling volatiles, we also passively collected insects using sticky traps placed around each flower during both the day and night. Both volatile sampling and insect trapping were also carried out at a control site approximately 20m from the flowers of interest. Throughout our sampling regime, we documented the blooming timeline of a wild *S. gigantea* specimen in Honolulu, HI (21.2908848, -157.8051319) in late June and early July 2022..

Conclusions: Our documentation of *S. gigantea* blooming will better prepare future researchers to plan their field work accordingly. Upon analysis of the collected volatile samples, our methods scheme will reveal the most effective pathway for the further analysis of *S. gigantea* and other volatile-producing plants. Our preliminary entomological survey indicates that flower sites were attended by 260% more arthropods than the control site. Arthropod attendance at flowers was primarily composed of Diptera (Sarcophagidae, Muscidae, Calliphoridae), but Hymenoptera was also observed (Formicidae).

Generating effective infographic-based social media content to translate concepts from forensic science.

Introduction: Fundamental misunderstandings of science presented in a courtroom can lead to inaccurate verdicts being handed down in criminal or civil trials [6]. Social media use in the U.S. is widespread, with 60% of U.S. adults reporting to use Facebook and 40% reporting to use Instagram [7]. For both of these sites, over 50% of users report to visit the platforms at least once per day [7]. However, only about 26% of social media users report to follow any science-focused social media accounts [8]. There is anecdotally a lack of forensic science social media accounts that are explicitly science-focused. Increasing engagement between real forensic scientists and social media audiences may promote a greater understanding of the fundamental concepts and goals of forensic science.

Objectives: To increase the engagement with the @cuhforensics social media accounts, we worked to generate infographics designed to summarize various forensic science fields, clear up common misconceptions about forensic science, and illustrate the history of forensics. We strategized to keep our infographics visually appealing and relatable without sacrificing information density. Our ultimate goal was to contribute to our audience's knowledge of foundational concepts in forensic science, and expand the reach of the @cuhforensics social media accounts.

Methods: Infographics were posted approximately twice per week on Tuesday and Friday evenings. We focused on maintaining a consistent and recognizable visual style, with large text and graphics in thumbnail images.
Infographic titles were kept short, and structured as simple questions we anticipated an audience of laypeople to have (e.g., "what is forensic taphonomy?"). When applicable, complex scientific concepts (e.g., techniques) were visually simplified using colorful graphics to illustrate the most important takeaways. Text-heavy slides were interspaced with graphic-heavy slides to avoid fatiguing the audience while providing a broad overview of the topic in question. Infographic captions kept a generalized structure of a "hook" statement followed by an invitation to view the content and a prompt to engage with the material (i.e., via liking or commenting). Hashtags were strategically used to target forensic science topics and communities on each platform, and were varied between each post to reach a wide audience.

Findings: In total, 13 infographics were generated between the months of June and July, 2022. History-based posts were found to be less successful than science-focused posts. From the beginning of the infographic campaign until the end, @cuhforensics exhibited over a 100% increase in reach on instagram. The @cuhforensics instagram page experienced also experienced an increase in followers over the course of the campaign. Of the top 10 posts by engagement on the @cuhforensics instagram page, 8 were generated through the infographic campaign.

Conclusions: The infographic campaign was most successful on instagram, which suggests that this presentation strategy is likely well suited for this visuals-focused platform. More concise text-based posts may be more successful on Twitter and Instagram. Reach and engagement has remained high on the @cuhforensics instagram page, suggesting that short-term social media campaigns may have long-term engagement impacts.

Delivering entomology-based extracurricular scientific education to K-12 students – strategies for success.

Introduction:

Though the United States ranks highly in University-level education [9], the U.S. falls behind in the global rankings for K-12 scientific education [10]. Becoming a scientific thinker is a lifelong endeavor, and is driven by interaction with scientific material both in and out of the classroom [11]. To promote further engagement with ecology-based material, interactivity-based methods for the delivery of scientific material for K-12 students is required. Observing live animals has been found to promote a greater connection with science and nature than simple classroom learning [12]. Additionally, providing resources for independent study outside of science outreach activities enables continued engagement with the material even when the providers are absent [13]. Outreach activities are not only beneficial to the recipients; scientists involved in outreach stand to increase their own communication skills, and have even reported downstream benefits to their research [14].

Objectives: I am a Scientist-STEM (IAS-STEM) is a mobile outreach program based in Honolulu, HI funded by Chaminade University's Division of Natural Sciences and Mathematics. The program has served over 47,000 K-12 students since its inception in 2009. Throughout the summer of 2022, I worked to introduce the first ecology-based module to the IAS-STEM curriculum, focusing specifically on entomology. The module heavily focused on hands-on interactions with arthropod specimens, and promoted interaction with entomology even after volunteer groups had left.

Methods: We present a framework for the delivery of information-rich entomology activities for K-12 students. Our methods began with a brief explanation of what entomologists do, and a demonstration of what kind of tools they use (e.g., insect nets, petri dishes, forceps). Students were then led to an outdoor area and allowed to use real entomology equipment to independently collect any arthropods they could find with the guidance of the instructors. After the allotted time, students were brought back to the classroom and allowed to observe and discuss their specimens. The instructors then walked the students through a simplified taxonomic key to identify certain arthropods. Students then competed in anatomy matching games, focused on illustrating differences in anatomy between locally important insect species (e.g., the coconut rhinoceros beetle). The final activity consisted of the instructors showing students their specimens under a video-projecting microscope. During this time, students were allowed to ask the instructors questions. At the conclusion of the programming, students were allowed to take home the petri dishes, hand lenses, and forceps they used during their arthropod collection for use on their own time.

Findings: Between June and July 2022, the entomology module of IAS-STEM visited 8 day camps and served approximately 150 students. The reception to the curriculum provided was anecdotally positive. On multiple occasions students expressed newfound interest in the discipline of entomology and expressed desire to continue exploring the field on their own time. Several students conveyed their interest in pursuing a future career in entomology. In one case, a student was observed multiple weeks after the course independently collecting arthropods with the equipment gifted by IAS-STEM and sharing his findings with friends.

Conclusions: Though the curriculum designed was relatively inexpensive and simple to deliver, the impact on the students was clear. The instructors observed an increase in interest for the study of

insects and enthusiasm for careers in entomology. IAS-STEM plans to continue to use entomology as a topic of instruction in their biology modules going forward.

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