

Discosoma Eradication at the Ala Wai Small Boat Harbor: Honolulu, O'ahu



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Field Report

Executive Summary

The Division of Aquatic Resources (DAR) identified the presence of a non-native species of corallimorph in Honolulu, O'ahu on July 13, 2020. The corallimorph was identified by a DAR biologist, David Gulko, as *Discosoma nummiforme*. Information provided by the source of the original specimen, stated the specimen was found in the Diamond Head area. *Discosoma nummiforme* was previously found at the Ala Wai Small Boat Harbor (SBH) in 1997 and was thought to have been fully eradicated in 2006. With the information provided on July 13, 2020 and the previous infestation at the Ala Wai SBH, DAR teams were sent out to conduct surveys at these locations. On August 4, 2020, the Hawai'i Coral Restoration Nursery (HCRN) and the Aquatic Invasive Species (AIS) Team conducted surveys at Black Point in the Diamond Head area and the Ala Wai SBH. *Discosoma nummiforme* were not found at Black Point; however, a large colony was identified at the Ala Wai SBH.

The AIS Team conducted eradication efforts from September 23, 2020 to October 15, 2020 at the Ala Wai SBH. Colonies of *D. nummiforme* were covered using two 60 lb bags of Quikrete, two 94 lb bags of Type I-II Portland Cement manufactured by Hawaiian Cement, and Z-SPAR A-788 Splash Zone Two Part Epoxy Compound. Scuba divers applied concrete, cement, and marine epoxy directly over *D. nummiforme* to eradicate the colonies. Once corallimorphs were completely smothered, the AIS Team conducted follow up surveys on October 15, 2020 to confirm the eradication of *D. nummiforme*.

Introduction

On July 13, 2020 a Division of Aquatic Resources (DAR) biologist, David Gulko, identified specimens of a non-native corallimorph being kept in the display tank of an aquarium store. The specimens were turned over to DAR voluntarily by the store owner, who informed DAR that the corallimorphs were donated by an individual. According to the aquarium store owner, the individual had stated they found the corallimorphs in shallow waters off Diamond Head. In December 1997, staff members of the Waikiki Aquarium discovered similar corallimorph specimens in the Ala Wai Small Boat Harbor in Honolulu, Hawai'i (Fig. 1A).

The DAR assisted the US Fish and Wildlife Service (FWS) Office of Law Enforcement (OLE) with an enforcement case under the Lacey Act and the Hawai'i Department of Agriculture (HDOA) Plant Quarantine Branch in another enforcement case. These agencies pursued an individual who was illegally maintaining the corallimorph in a home

aquarium and had illegally introduced the species to the Ala Wai SBH. Corallimorphs confiscated by HDOA from the individual and the Ala Wai SBH were identified as *Discosoma nummiforme* Rüppell & Leuckart, 1828 by both the Waikiki Aquarium and DAR biologist David Gulko. The area of the Ala Wai SBH occupied by *D. nummiforme* was approximately 460 m². The HDOA and DAR conducted eradication efforts at the Ala Wai SBH numerous times from 1999 to 2006.

Initial eradication efforts utilized mallets and chisels to remove materials where *D. nummiforme* were attached. In areas where material could not be removed, Plaster of Paris was used to smother colonies. The first and second attempts were unsuccessful due to the soft and easily torn tissues of *D. nummiforme* and the species ability to reproduce asexually via pedal laceration (Chadwick-Furman & Spiegel 2000). In May 2005, future eradication efforts were handed to DAR's Aquatic Invasive Species (AIS) Team.

Surveys of the Ala Wai SBH were conducted by the AIS Team to determine the initial footprint of the invasion. Many of the *D. nummiforme* colonies were growing on rubble in flat portions of the reef. In August 2005, the AIS Team removed as much *D. nummiforme* with the use of hammers and chisels. Excavated material was bleached to kill all organisms growing in or on the rocks. The AIS Team determined that using sandbags to smother the remaining colonies was the best approach. This eradication effort proved successful and the AIS Team found no remnant colonies in surveys conducted in September 2006. Follow up surveys in 2007 and 2008 found no *D. nummiforme* in the original infestation area. The rediscovery of *D. nummiforme* in July 2020, in the same area as the 1997-2006 infestation, raised concerns that the species was either not fully eradicated or reintroduced.

After *D. nummiforme* specimens were turned over to David Gulko in July 2020, the DAR Hawai'i Coral Restoration Nursery (HCRN) and the AIS Team conducted field surveys at Diamond Head off of Black Point (Fig. 1B) and the Ala Wai SBH (Fig. 1A) on August 4, 2020. Black point was chosen by David Gulko because it had optimal environmental conditions required for *D. nummiforme* and there were similarities observed in the live rock present in the area and the pieces of live rock the specimens were attached to. Surveys at Black point did not uncover any presence of *D. nummiforme* in the area. The HCRN and AIS teams proceeded to the Ala Wai SBH to continue the investigation.

The 1997 infestation site at the Ala Wai SBH was the main focus of the August 4, 2020 surveys. Colonies of *D. nummiforme* were found adjacent to the boat slip 806, which was one of the locations containing the corallimorph eradicated in 2006. Specimens from the Ala Wai SBH were collected and brought to the Anuenue Fisheries Research

Center (AFRC) to compare to the specimens from the aquarium store. Once the presence of *D. nummiforme* was confirmed at the Ala Wai SBH, the DAR AIS Team planned an eradication effort, which was conducted from September 2020 to October 2020.

Materials/Methods

During the August 4, 2020 surveys at the Ala Wai SBH, members from the HCRN (Norton Chan) and AIS (Jon Ehrenberg) teams conducted a roving snorkel survey along the entire SW length of the finger pier (Fig. 1A). From the break water to approximately 2.5 m away from the SW edge of the pier, the reef topography is flat pavement/rubble with depths ranging from 0.5-1.5 m. Pavement transitions to a very steep shelf with rubble and silt at the bottom with depths ranging from 4-6 m. Surveyors swam at a slow speed and spaced themselves 2 m apart, with one swimming over the shallow reef pavement and the other along the shelf of the reef. The survey ended when both team members swam around the terminal end of the break water and determined *D. nummiforme* was not present in any area other than adjacent to boat slip 806.

Norton Chan and Jon Ehrenberg photographed the colonies on the shallow reef pavement with scale bars in frame for future planning of eradication efforts. Small colonies and individual polyps were noted in the rubble and sediment at the bottom of the shelf and under the pier. Small colonies and polyps attached themselves to small pieces of rubble, plastic, glass, rubber, and metal (Fig. 2B). These factors were taken into consideration when planning eradication efforts.

Kimberly Fuller, DAR Biologist and AIS Team lead, and David Gulko determined that using 60 lb bags of Quikrete to smother the colonies was the best course of action. On September 23, 2020, the AIS Team transported the necessary materials to the area to begin the eradication. In water operations were conducted via open circuit scuba, with two AIS Team divers (Kimberly Fuller and Wesley Dukes). Before the eradication began, with the use of UV underwater flashlights, divers surveyed an area extending 10 m out from the border of the *D. nummiforme* footprint (Fig. 2). *Discosoma nummiforme* fluoresces when exposed to UV light; therefore, UV flashlights helped divers locate small polyps nestled in the sediment in the low visibility conditions at the Ala Wai SBH. The area of the colonies and sizes of polyps were measured and recorded. Once divers confirmed the location of *D. nummiforme* colonies and polyps, the eradication began.

On the pier, three AIS technicians (Jesse Boord, Genivive Devine, and Jon Ehrenberg) mixed one 60 lb bag of Quikrete with seawater in five gallon buckets. A concrete mixing drill attachment and an 18 Amp HILTI SFH Cordless drill were used to mix the Quikrete

to the correct consistency (similar to modelling clay). With small shovels and hand trowels, the mixed Quikrete was put into one gallon Ziplock bags. Filled bags were handed off to divers, who applied the Quikrete to the colonies. Underwater, divers pushed the mixed concrete out of the bags and directly onto colonies (Fig. 2A). The mounded concrete was pressed down evenly to around a five centimeter (cm) thickness, extending roughly 10 cm out from the border of the colony. As a test, a Ziplock bag filled with mixed Quikrete was used to cover a small colony in order to determine if the concrete would cure quicker and better if it was not exposed to seawater. Additionally, a dry bag of Quikrete was cut open on the bottom face of the bag and placed over parts of a colony to determine if this method would be more effective and less time consuming. All equipment was packed up and bleached at AFRC to prevent the further spread of any invasive species.

On September 24, 2020, the AIS Team returned to the site to continue eradication efforts. Divers entered the water and assessed the area and work from the day before. The area was photographed and exposed colonies/polyps were located and marked for eradication (Fig. 3). Some small colonies and individual polyps, attached to marine debris, were collected, photographed, and bleached back at AFRC. Divers determined that the Ziplock bag left over night had cured and the concrete applied to the reef had also hardened. However, the dry bag of Quikrete had not cured, but was left in place to finish hardening. Taking issues from the previous day into account, the AIS Team decided to use 94 lb bags of Type I-II Portland Cement manufactured by Hawaiian Cement instead of Quikrete. One bag of cement was mixed, bagged, and applied using the same techniques as on September 23, 2020 (Fig. 4). After work was completed at the Ala Wai SBH, all equipment was transported back to AFRC and bleached thoroughly.

The AIS Team conducted a follow up inspection of the area on September 29, 2020. Two divers entered the water and surveyed the immediate area to determine if initial eradication efforts were successful. Small colonies and individual polyps of *D. nummiforme* were located and photographed (Fig. 3). Polyps growing on pieces of rubble and marine debris were removed from the site, secured in a gallon size Ziplock bag, and bleached on site. Remnant living polyps in the large dense *D. nummiforme* colony were smothered using one 94 lb bag of Type I-II Portland Cement. Methods for mixing and application of cement were identical to those used on September 23 & 24, 2020. Once most of the exposed *D. nummiforme* colonies were smothered, divers surveyed the benthos directly under and along the length of the pier to confirm that all colonies and polyps were eradicated. The AIS Team determined that *D. nummiforme* was only present in the area of boat slip 806. Further action was required to spot treat exposed polyps on crevices that cement could not completely cover.

On October 08, 2020 the AIS Team returned to the site to continue the eradication of *D. nummiforme*. Divers determined that approximately three to four polyps were still exposed. In order to fully smother the remaining polyps on vertical surfaces in crevices of the reef, Z-SPAR A-788 Splash Zone Two Part Epoxy Compound (marine epoxy) was used by divers. Equal amounts of parts A & B were mixed by hand until uniformly combined, then handed to divers in the water. Marine epoxy was directly applied to exposed polyps and pressed into the reef to adhere it to the surface (Fig. 5). The AIS Team returned to the site on October 15, 2020 to take images of the site and cover any remaining polyps with marine epoxy. Three polyps were found and smothered, a quick visual inspection of the area was conducted and the AIS Team determined that *D. nummiforme* was not visually present at the site.

Results & Discussion

Based on initial measurements of the dense *D. nummiforme* colony, the large patch was 1.25 m across its longest axis and 1.2 m at its secondary axis. Individual polyps, in the large colony, were not counted and recorded. From the upper edge of the large colony in the shallow portion of the reef to the area under the pier, the total footprint of *D. nummiforme* stretched 4.9 m (Fig. 2). The shallowest depth where *D. nummiforme* occurred was 1.2 m and the deepest area was at 4.6 m. Though polyps were not individually counted, AIS Team divers found that the largest polyp was 13 cm in diameter and the smallest polyps were <1 cm.

Eradication efforts in September 2020 and October 2020 reduced colony and polyp numbers to zero. The AIS Team was presented with a number of issues during the eradication of *D. nummiforme*. Quikrete and Type I-II Portland Cement quickly caused issues as it reduced visibility for divers and was difficult to apply uniformly (Fig. 3, Fig. 4). The concrete and cement could not be applied to vertical surfaces as it crumbled and fell off any surface it was placed on. The AIS Team attempted to remedy these issues by mixing both the concrete and cement to a much thicker consistency, similar to modeling clay. The only surfaces where concrete and cement applications were effective were on horizontal or near flat surfaces. In some cases, cement and concrete were still unable to cover portions of the colony, even on the flat surfaces of the reef (Fig. 3). Marine epoxy was required to completely cover *D. nummiforme* growing in crevices and on vertical surfaces of the reef. The issues with reduced visibility and adherence to surfaces were not present during the application of marine epoxy.

Taking the average cost of the concrete, cement, and marine epoxy into account, the use of concrete, then cement in combination with marine epoxy was the most cost

effective. Though the application of Quikrete was not completely effective, the 60 lb bags of Quikrete were the most inexpensive at \$7.97 per bag. The 94 lb bags of Type I-II Portland Cement were \$19.99. The two gallon buckets of Z-SPAR A-788 Splash Zone Two Part Epoxy Compound were the most expensive material purchased for \$439.99. Using two bags of cement and two bags of concrete to cover large portions of the colony growing on horizontal areas of the reef cost approximately \$58.16. The amount of marine epoxy used was approximately $\frac{1}{4}$ of a gallon from parts A & B; therefore, the total cost for the epoxy used was ~\$110. The total cost of the raw materials used in this eradication effort was approximately \$168.16. If solely marine epoxy was used to cover the entire colony area, the eradication would have been more expensive.

The methods used in this eradication differed from those used in the original eradications conducted from 1999 to 2006. Previous eradication efforts used sandbags to smother colonies. On the recommendations of DAR biologist, David Gulko, the AIS team decided to use cement during this eradication. Concrete and cement used in the context of aquatic invasive species eradication is novel. There has been mention of using cement powder in the eradication of invasive tunicates in Sitka, Alaska, but it has not been put into practice (McCann et al. 2013). The AIS Team's efforts to eradicate *D. nummiforme* using cement and concrete has revealed the costs and benefits related to these materials. Based on past success in eradication of corallimorphs, if reinfestation occurs it is suggested that eradication of *D. nummiforme* should be done using methods such as sandbag smothering or pulverized chlorine pucks in combination with plastic tarps and sandbags (Work et al. 2008, Work et al. 2018).

Rediscovery of *D. nummiforme* in August 2020 at the Ala Wai SBH, 12 years after its initial eradication in the area, could be attributed incomplete removal in 2008 or reintroduction by an outside entity. If eradication efforts in 2008 were not successful, it is possible that remnant polyps could have reproduced asexually over the 12 years that the area was not continually monitored. It should be noted that, the reported fast replication rate of corallimorphs and their documented invasions on coral reefs over short time periods needs to be taken into consideration in this case (Chadwick-Furman & Spiegel 2000, Kuguru et al. 2004, Work et al. 2008, Work et al. 2018). Over the span of five years, an invasive corallimorph completely smothered large reef areas on the Palmyra Atoll (Work et al. 2018). If replication rates for *D. nummiforme* are similar to the corallimorph observed in Palmyra, then one would have expected to see much higher benthic coverage after a 12 year period. Additionally, the Ala Wai SBH has environmental conditions that are ideal for *D. nummiforme*. Corallimorphs thrive in shallow reef areas, with low water movement and higher nutrient input (Kuguru et al.

2004). Taking these factors into account, there is an argument for the potential recent reintroduction of *D. nummiforme* in this area.

The area of the Ala Wai SBH where *D. nummiforme* was found is easily accessible by the public. Adjacent to the *D. nummiforme* colonies, there was a ladder attached to the finger pier that allowed access to the shallow reef area. The lack of security, easy access to the reef, and the recurrence of *D. nummiforme* in the same location it was found in 1997, points to the possible reintroduction of this corallimorph. This is a cause for concern in the future because if specimens of *D. nummiforme* are being held in an individual's home, the potential introduction of this species in other areas could be troublesome. Corallimorphs are documented to be highly competitive and their introduction on coral reefs could cause phase shifts to corallimorph-dominated reefs, decimating coral populations (Kuguru et al. 2004, Work et al. 2008, Work et al. 2018). This phenomenon was observed at the Ala Wai SBH, with polyps of *D. nummiforme* surrounding native coral species (Fig. 6).

Follow Up Surveys

Following an additional report of an unknown *Discosoma* sp. at the same location in the Ala Wai SBH, the AIS team conducted a survey in June of 2024 to assess any potential regrowth of *D. nummiforme*. Two snorkelers entered the water with UV underwater flashlights to attempt to locate any trace of *Discosoma*. Luckily, no growth was found.

Conclusion

Colonies of *D. nummiforme* were rediscovered at the Ala Wai SBH in August 2020. Eradication was conducted through the months of September and October 2020, using Quikrete concrete, Type I-II Portland Cement, and Z-SPAR A-788 Splash Zone Two Part Epoxy Compound. Polyps and colonies of *D. nummiforme* were smothered and the area was surveyed to confirm the absence of the corallimorph. This area will need future monitoring to ensure that *D. nummiforme* has been completely eradicated. Given the fast replication rates and modes of asexual reproduction of this species, there are prominent concerns about the ability of *D. nummiforme* to become an invasive species. The site at the Ala Wai SBH will be closely monitored and any future reported sightings of *D. nummiforme* will be responded to appropriately. Initially, quarterly monitoring of the area is suggested, then annual surveys will need to be conducted.

References

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Appendix A: Maps and Figures

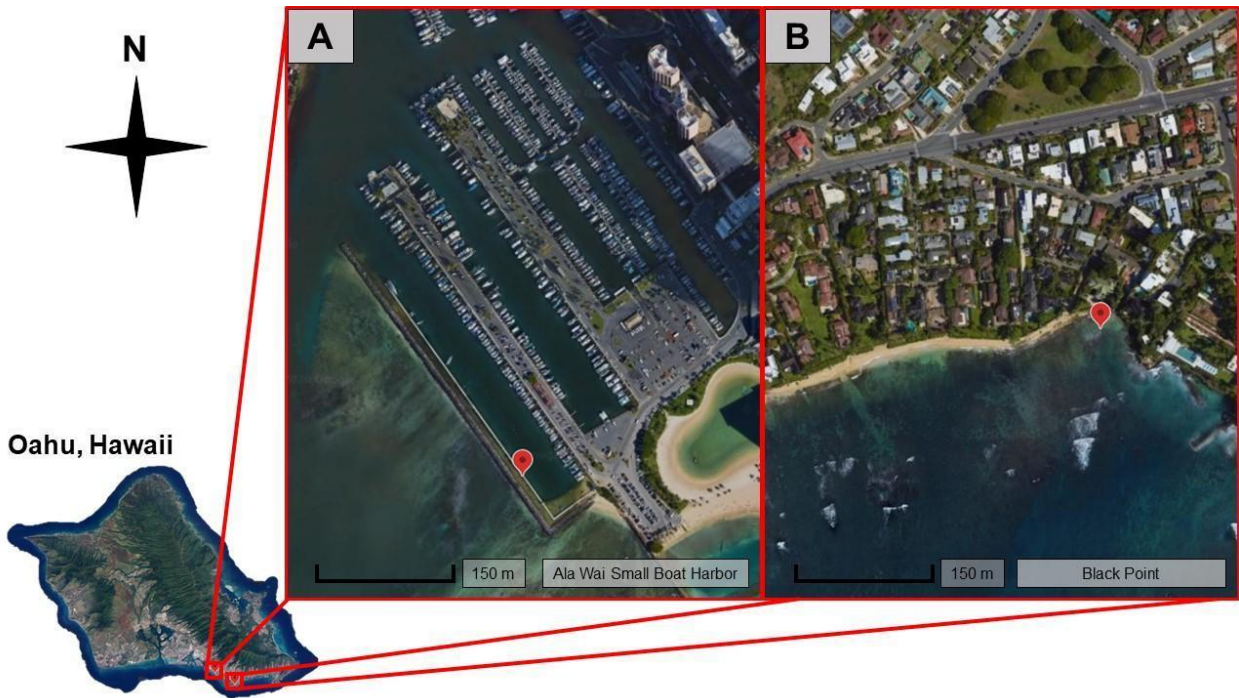


Figure 1. Map of the island of O‘ahu, Hawai‘i. **(A)** Satellite imagery of the Ala Wai Small Boat Harbor, marked with GPS coordinates of the location of *Discosoma nummiforme* colonies in September 2020. **(B)** General location, at Black Point (Diamond Head area), of August 4, 2020 *D. nummiforme* surveys.

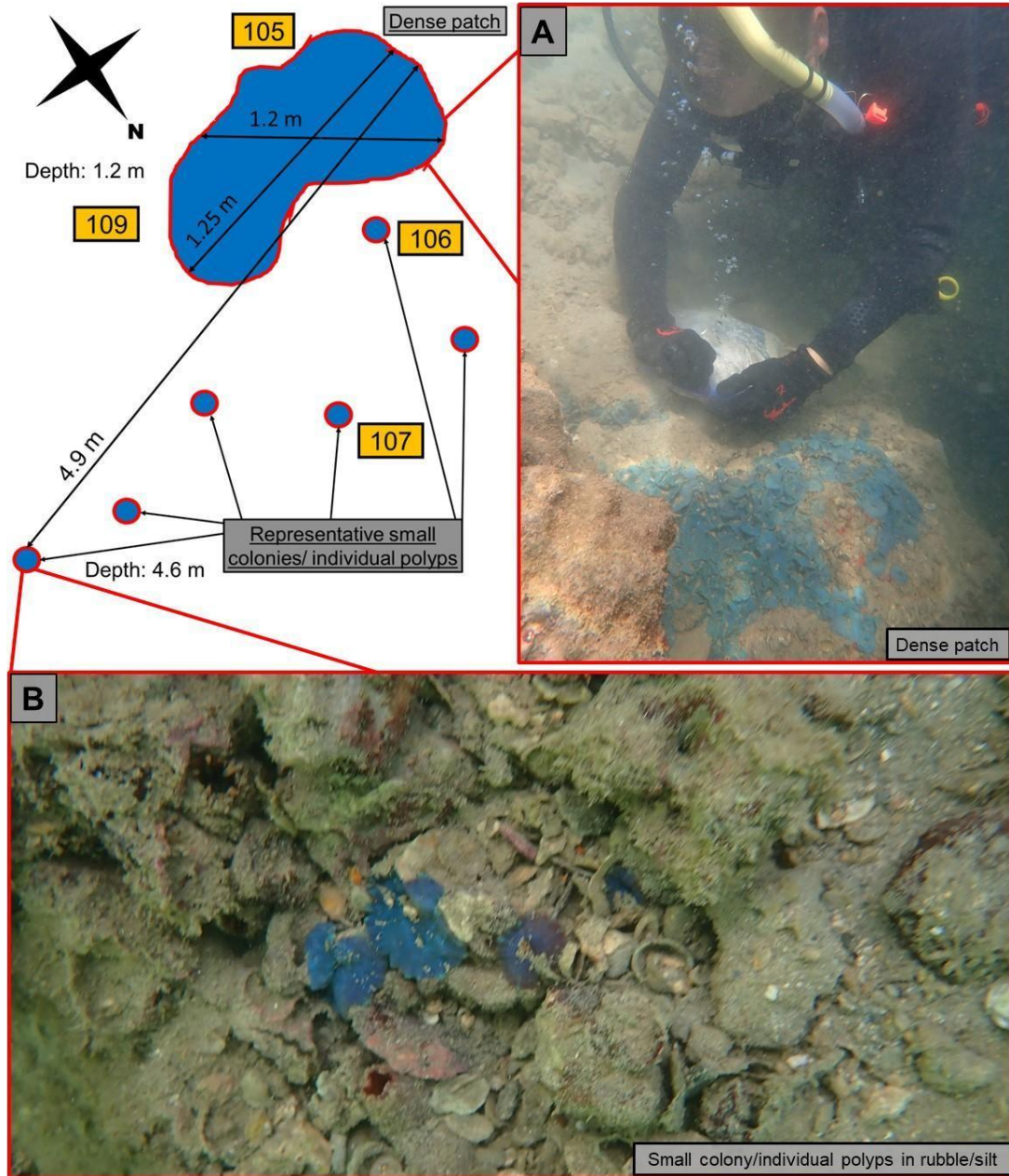


Figure 2. Rough diagram of *D. nummiforme* footprint at Ala Wai SBH on September 23, 2020. Large dense colony is outlined in red, with measurements of the two largest axes displayed in black. Smaller colonies/individual polyps are represented by the small blue circles outlined in red (size not to scale). Cattle tags, placed around the footprint of the invasion area, are represented by the yellow rectangles with numbers and position corresponding to the actual tags at the site. **(A)** AIS Team diver, Wesley Dukes, applying Quikrete to the large *D. nummiforme* colony. **(B)** Small *D. nummiforme* colony and individual polyps attached to pieces of rubble sitting in the silt at the bottom of the shelf.



Figure 3. *Discosoma nummiforme* polyps that were not covered after the September 23, 2020 application of two 60 lb bags of Quikrete.

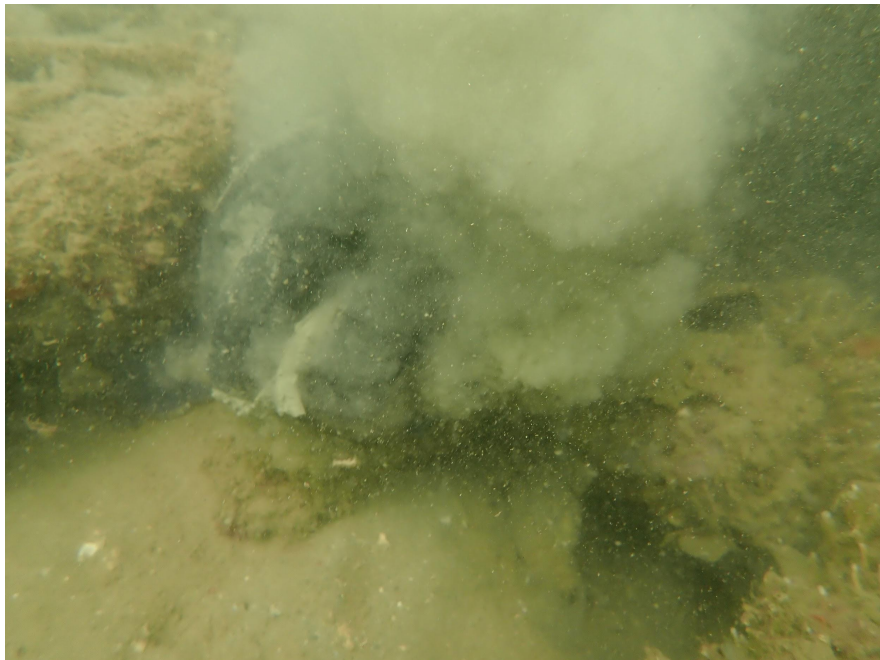


Figure 4. Plume created by the application of Type I-II Portland Cement to the largest *D. nummiforme* colony on the reef flat.

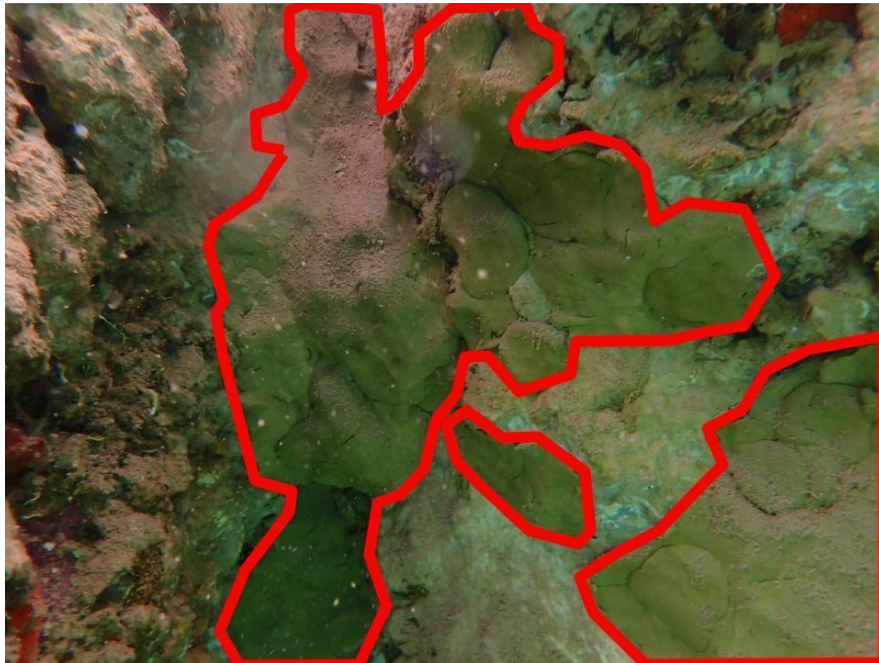


Figure 5. Z-SPAR A-788 Splash Zone Two Part Epoxy Compound pressed into vertical reef crevices. Image was taken post application on October 15, 2020 with cured portions outlined in red.



Figure 6. *Discosoma nummiforme* colony surrounding a *Pavona varians* colony. *Pavona varians* is a native species of encrusting coral that is commonly found on shallow coral reefs in Hawai'i.