

**Final Report for Project: Create an Aquarium Display of Two Species
of Concern; a Hawaiian Coral and a Brachiopod; and to Perform
Genetic Studies on the Former**

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Introduction

The Species of Concern (SOC) program of the Protected Resources Division of the Pacific Islands Regional Office (PIRO) of the National Oceanographic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS) aims to conduct proactive conservation activities to preclude the listing of future species. Two of the Pacific Islands Region species of concern are the inarticulated brachiopod *Lingula reevii* and the Hawaiian reef coral *Montipora dilatata*.

The inarticulated brachiopod *Lingula reevii* is believed to be endemic to Kaneohe Bay, Oahu, Hawaii, where it was once abundant throughout the southern end of the bay. The species has declined in density from 500/m² in the 1960s (Worcester 1969) to 100/m² (Emig 1981). Past surveys of Kaneohe Bay populations suggested a distinct decrease in abundance following the diversion of sewage effluent from the Bay in 1978/1979. Surveys in 2004 reported a dramatic decline from historical densities, from maximum estimates of 500 individuals/m² and 100 individuals/m², to a maximum density of only four individual/m² observed in 2004. Additional extensive surveys conducted in 2007 and 2008 have found that the *L. reevii* population had further declined to a maximum average density of 0.08 individuals/m², and a shift has occurred in the population to deeper reefs and sandy habitats (Hunter 2008a). As one means of conserving the declining population, it was decided to explore the potential of captive husbandry. *Lingula reevii* is a filter feeder, has separate sexes, is a broadcast spawner, the population sex ratio is 1:1, and the planktonic stages are non-metamorphic. Little else is known of its biology and, prior to this project, no long term, captive husbandry of this species had been successful.

The Hawaiian reef coral *Montipora dilatata* is one of the rarest stony corals known. Despite intensive surveys it has been reported only from the Hawaiian archipelago, where it is restricted to two localities: Kaneohe Bay on Oahu, and Maro Reef in the Northwestern Hawaiian Islands. It remains unclear whether the '*M. dilatata*' found at Maro Reef is the same species as occurs in Kaneohe Bay (Fenner, 2005); if not, it would make the status of this species even more precarious and the conservation of the Kaneohe Bay population even more critical. *Montipora dilatata* was formerly abundant in Kaneohe Bay, however, a variety of factors, including freshwater kills, sedimentation, physical habitat degradation, overgrowth by alien algae, or anchor/boat damage (NOAA 2007) have contributed to its drastic decline there. Additionally, following a 1999 coral bleaching episode in Kaneohe Bay, many of the remaining large stands of *M. dilatata* there died off and did not recover. Extensive surveys of Kaneohe Bay conducted by Waikiki Aquarium and Department of Land and Natural Resources (DLNR) personnel during 2000 and focusing on *M. dilatata* identified only three living colonies. In 2007, coral experts again only positively identified three *M. dilatata* colonies in Kaneohe Bay, and were unsuccessful in clearly differentiating it from

other species within the same genus, particularly *M. incrassata*. In 2008, field surveys identified 20 *M. dilatata* colonies in Kaneohe Bay, although not the same colonies originally identified in 2000, which have not been relocated (Hunter 2008b).

Project Background

- **Lingula reevii**

In October 2006, a custom acrylic tank was built exclusively for husbandry *L. reevii*. The system is open, with a reverse flow of water through the fine sand bed. Various invertebrates, including feather duster worms (*Sabellestarte* sp.) and burrowing amphipods, a few pieces of rubble, and several strands of sea grass (*Halophila* sp.) were added to simulate the natural environment (Figure 1).



Figure 1. *Lingula reevii* holding tank showing fine sand layer and drop bucket used to provide phytoplankton to the animals.

Lingula reevii has never before been maintained in captivity for an extended period, and so much of the husbandry research was novel and challenging. A plankton diet was provided several times daily to mimic the nutrient rich conditions in which this species occurs in the wild. Three years later, six of the seven specimens originally introduced into the husbandry tank are still alive, and we are confident about being able to maintain this species in captivity (Figure 2).



Figure 2. View of sand surface in *Lingula reevii* holding tank. One specimen resides within each of the mesh circles. The three respiratory pores of one animal are clearly visible in the upper right circle.

Research to measure growth and record husbandry information of this species is ongoing, and is providing novel and much needed data on this species that is of relevance to ecological studies of the wild population.

The final objective in the husbandry *L. reevii* is to achieve successful reproduction in captivity. In this we have not yet been successful. In future we plan to add further specimens to the husbandry tank and then manipulate environmental conditions (light regime, temperature, etc.) to try to stimulate breeding.

- ***Montipora dilatata***

From the three colonies recorded in the 2000 survey, four fragments were removed and brought to the Waikiki Aquarium, where a holding tank was established to propagate rare coral species. Two fragments were placed on exhibit and two were placed in the rare corals holding tank. By 2002, the two fragments in the holding tank had increased in volume and number to several colonies over 20 cm in diameter and so it was decided to move two small colonies to an outdoor exhibit, a 26.6 m³ open system containing

Hawaiian corals and fishes. Each of these colonies is now (August 2009) over 35 cm in diameter and 20 cm in height. In 2004, the Aquarium received a small grant from the DLNR to construct a coral “ark” tank behind the scenes, the purpose of which was to house rare Hawaiian corals to serve as a genetic and specimen repository. The first specimen placed in this system was a 10 cm diameter colony of *M. dilatata* in October of 2004; by March, 2007 that colony had reached over 40 cm in diameter and 20 cm high, and consists of three distinct colonies; a result of incidental fragmentation.

Based partly on the Aquarium’s pioneering research and previous success in cultivating a diverse array of coral species, including *M. dilatata*, in August 2006 NOAA’s National Marine Fisheries Service (NMFS) awarded the Aquarium a grant for a project to propagate *M. dilatata*. Modeled after other coral propagation systems used successfully at the Aquarium, the *Montipora* propagation system was completed in October 2006. The 2.5 m³ open system draws from a 24 m deep saltwater well beneath the Aquarium as the sole water source (Figure 3). The chemical composition of the well water makes for accelerated algal growth after initial setup of the propagation system, but also promotes excellent coral growth.



Figure 3. *Montipora dilatata* holding tank in the Coral Farm at the Aquarium.

After construction, live rocks were introduced and plastic shelving mounted onto fiberglass threaded support rods was added, on to which were mounted 25 pieces of *M. dilatata* fragmented from the coral “ark” tank specimen and ranging in length from 5.5 cm to 10 cm. Herbivores (four Hawaiian convict surgeonfish *Acanthurus triostegus* and ten collector urchins *Tripneustes gratilla*) were added to control diatom and algal growth. Within six months of being introduced, the fragments had already attached to base rock and begun to exhibit growth. The fragments have continued to grow and, in the near future, will be large enough to themselves be fragmented for further propagation (Figure 4).



Figure 4. The fragments placed in the dedicated *Montipora dilatata* holding tank in 2006 have grown well.

In summary, the original fragments of *M. dilatata* brought to the Waikiki Aquarium have flourished into healthy colonies, even though colonies in the wild continue to be extremely rare. The husbandry portion of this portion of the project has clearly been very successful, and we are confident of being able to maintain and propagate this species in captivity. The successful captive propagation of *M. dilatata* acts as a proactive measure that provides a population reservoir in the event of extinction in the wild. Ultimately, when conditions in Kaneohe Bay are more favorable, the success of this captive propagation program might eventually facilitate the reintroduction of this species into its natural habitat.

Education and Outreach Components

An objective of this project was to display these two species to the public, using them and their threatened status as model organisms to educate audiences on conservation issues and protective measures.

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In 2008 a dedicated Kaneohe Bay exhibit was completely remodeled to accommodate and display living *M. dilatata* (Figure 5). Since being placed on display, the coral specimens have adapted well to the exhibit conditions and are growing strongly (Figure 6). The normal life mode of *Lingula reevii* is to be buried under the sand and not visible. This organism is not suited for live public display, but is photographed and discussed in detail in the video associated with this exhibit.



Figure 5. Kaneohe Bay exhibit at the Waikiki Aquarium.



Figure 6. *Montipora dilatata* on exhibit.

Educational material relating to this exhibit includes graphical and video information explaining the education and conservation component of protecting species in the wild, highlighting *M. dilatata* and *L. reevii* as exemplars. Graphic information consists of a static photo identification guide of *M. dilatata* that includes the species' common and scientific names; also included is a 'unique species' decal, which is used throughout the Aquarium to indicate unique or rare species on display (Figure 7).



Figure 7. Identification photograph of *Montipora dilatata*, part of live exhibit. Nautilus decal indicates this to be one of the Aquariums "unique species".

A video screen with speakers has been mounted above the exhibit; this plays an audiovisual video loop which prominently features *M. dilatata* and *L. reevii* and their threatened status. The video also explains the research perspective of this program and how it is striving to conserve these species (Figures 8 and 9). Special emphasis is given to the importance of proactive efforts aimed at conserving even ‘obscure’ species, such as these two, in an ecosystem context.



Figure 8. Kaneohe Bay Exhibit image of *Montipora dilatata* as shown on video screen.



Figure 9. Video image of *Lingula reevii* being measured with calipers as part of the growth study.

Mutual benefits of this project

Throughout its 3-year duration, this collaboration to promote conservation of these two species of concern has been mutually beneficial to the Aquarium and to NMFS.

The mission of the Waikiki Aquarium is founded upon conservation, education and research on Pacific marine life, and this project has fulfilled all three components. These advances would not have been possible without this collaboration.

From a NMFS perspective, information of conservation programs and an educational component has been made accessible to a broad community: the video message reaches roughly 320,000 Aquarium visitors each year. The public at large has been made aware of these species and their plight, and has been able to see them, probably for the first time, in life for *M. dilatata* and on video for *L. reevii*.

Additional outreach on this project has occurred through an article in Kilo'ia, the Aquarium's quarterly magazine, which is distributed to over 2,700 households. The status of *M. dilatata* and our efforts to conserve it were also prominent in an article about the Aquarium's coral propagation program featured in the summer 2008 edition of Kaunana, the research publication of the University of Hawaii.

It should also be noted that the entire Aquarium audio wand commentary is being updated; when complete this will also provide a new commentary on *M. dilatata* and *L. reevii* that will be listened to by every visitor. Japanese, Spanish, German, Hawaiian and Chinese language versions will also be available.

Lastly, the video presentation ends with a full screen credit showing the NOAA logo and thanking NOAA for their support of this project (Figure 10).



Figure 10. Acknowledgement to NOAA in the video presentation.

An ancillary benefit from this project is that the corals housed at the Waikiki Aquarium constitute an easily accessible research resource for biologists at UH and elsewhere. As indicated in the study described in part two of this report, much remains to be learned of the taxonomy of Hawaiian corals of the genus *Montipora*. A 'bank' of coral species such as that housed at the Aquarium, which includes several threatened and endangered species, is an invaluable resource for studies of this nature, so that scientists and resource specialists may better manage them in the wild.

An understanding of the taxonomy and biology of a species is fundamental to making informed decisions regarding its ecology, conservation status and management. Knowledge of this aspect is incomplete for Hawaiian corals. To address this shortcoming for *M. dilatata*, the second goal of this project was to use genetic tools to establish accurately its taxonomic status. The results of this study are attached as a separate report.

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