# Aquaculture of Hawaiian Marine Invertebrates for the Marine Ornamental Trade, Year 1

## General Information

*Reporting Period* October 1, 2002–March 31, 2004 (final report)

*Funding Level*

| Year | Amount |
|---|---|
| **1** | **$55,000** |

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# Objectives

### *Feather Duster Worm*

1. Determine the appropriate feed and feeding regimen to result in captive spawning of collected broodstock.
2. Document larval development stages and determine time to settling.
3. Facilitate larval settlement and determine settlement preferences on different substrates.
4. Determine growth time of settled worms to market size.
5. Summarize results in technical bulletins, newsletter articles, and where appropriate, manuscripts to be submitted to peer-reviewed journals for publication.

### *Soft Coral*

1. Determine the appropriate type of substrate and water motion for culturing each target species. Also, determine any interaction effect from the two variables.
2. Document baseline growth rates for each of the target species.
3. Determine other critical variables that may contribute to optimal growth. This determination will be based on observations and experiences during the course of the first year.
4. Determine preliminary marketability and crude economic feasibility information for the target species.
5. Develop, in theory, a larger-scale prototype system that would incorporate the optimal conditions and growth information obtained during Year 1 and would also include any marketing information.

# Principal Accomplishments

### *Feather Duster Worm*

#### *Objective 1: Determine the appropriate feed and feeding regimen to result in captive spawning of collected broodstock.*

This objective was switched with the induction-of-spawning activities, which is part of the Year 2 project activities. In its place are the results of the induction-of-spawning trials. The feeding regimen work will be reported under the Year 2 project.

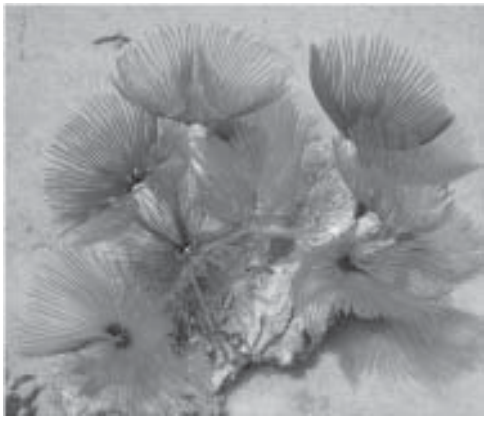

FIGURE 1. *Sabellastarte spectabilis*

*Project staff successfully induced spawning in feather duster worms.*

Spawning trials were conducted in October 2002 in four 15-gallon aquaria, and 20 feather duster worms were placed in each tank. The feather duster worms were collected from the waters surrounding the Hawaii Institute for Marine Biology (HIMB). Each tank was equipped with a continuous flow of seawater and a single airstone. To induce spawning, five individuals per treatment tank were ablated at the base where the coelomic contents could be viewed under a compound microscope. The intent was to ensure that there were both males and females and not to set a particular sex ratio. The ablated worms were placed in their respective tanks. Control tanks also consisted of the same number of worms, but the only difference was that the five worms were handled but not ablated before being placed back into their respective tanks. Three days after the ablation, the feather duster worms in Treatment tanks 1 and 2 were observed to be spewing gametes. It was observed that not only were the ablated worms spawning, but those that were not ablated as well. The entire experiment was repeated in November 2002, and the same results were obtained. In both trials, larvae were examined under a compound microscope to obtain the developmental series.

Additional spawning trials were conducted testing a variety of other spawning techniques (e.g., temperature and KCL injections). Four aquaria were stocked with ten mature worms. Heaters were placed in two of the four tanks. Temperature was increased in the two aquaria to 29°C for a period of 48 hours. Water in the control tanks was maintained at ambient conditions (approximately 24° C). After 48 hours, no spawning had occurred in any of the four tanks. The experiment was replicated a second time during which water in one of the heated tanks was found to contain very low levels of sperm, but no eggs. A third trial did not result in any spawning activity. A similar experiment was conducted to test the effect of decreasing instead of increasing water temperatures. Water in two of the four tanks was cooled

to approximately 18°C. No spawning was observed with this treatment as well. Lastly, following the procedures used to spawn sea urchins (0.5 ml 0.55 M potassium chloride injections) were also attempted. All worms subjected to this treatment died during the process. To date, the only successful means of spawning the feather duster worm in captivity is the ablation technique.

Initial activities at the Oceanic Institute (OI) revolved around the hiring of two technicians (Ethan Morgan and Jennifer Hix). Two hundred fifty feather duster worms were purchased from a local collector. The worms came from Dave Reinhardt and were collected in Kaneohe Bay. All animals were quarantined outside OI's campus in order to determine whether any of the worms harbored any penaid shrimp pathogens. The majority of the work involved construction of 15 feather duster tanks. Each feather duster tank consisted of a 75-L plastic container, 6-L egg collector, seawater supply, air supply, and shrimp pond water supply. Each tank was stocked with 15 broodstock-size feather duster worms, and the experiment began in earnest in January 2003. Three tanks received 100% shrimp pond effluent, another three tanks received 50%, and the remaining tanks received 25% pond effluent. Measuring growth was problematic. Survival, however, was clearly impacted by the amount of pond effluent. The tanks that received the 100% pond effluent suffered the highest mortalities and required constant tank maintenance due to the sludge build-up that pond effluent brought. Growth was barely detectable in all of the treatments, and it is suspected that the amount of organic material in the shrimp pond effluent is too high for the culture of the feather duster worm. No spawning was detected in any of the treatments.

### *Objective 2: Document larval development stages and determine time to settling.*

*Larval development stages were documented. It was observed that larvae settled within 7-8 days.*

The successful induction-of-spawning trials conducted at HIMB provided the opportunity to document the early life history of the feather duster worm. First cleavage was detected within 30 minutes after spawning at 26°C. Development was rapid, with hatching occurring with seven hours after spawning. Development of the free-swimming larvae progressed over the course of a week, and within 7–8 days, the larvae settled to the bottom of the tank at which time the distinctive cetae were present. Elongation of the anterior portion of the body with the characteristic "feather" began soon after settling of the larvae. Photographs were taken to document the various stages. The induced spawning and developmental stages of the

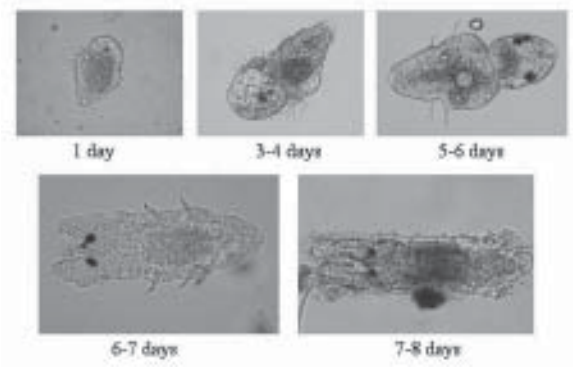


FIGURE 2. *Larval stages of the fan worm* Sabellastarte spectabilis.

feather duster worm were summarized in three presentations given by David Bybee.

### *Objective 3: Facilitate larval settlement and determine settlement preferences on different substrates.*

*Larval settlement investigations were hampered by predation.*

Three different settling devices were constructed. Essentially, a 1-meter square was constructed out of 1-inch PCV piping, and nylon netting, black plastic netting, or concrete devices was stretched across it. These were placed at strategic locations around HIMB and were monitored bimonthly. After almost one year of deployment, no settling of feather duster worms was observed, despite their being placed in areas where the density of feather duster worms exceeds ten individuals per square meter. The level of predation on these worms is apparently extremely high, and a new device will need to be constructed. Alternatively, with the availability of feather duster larvae, the investigations may be a focal point to be worked on in the laboratory rather than out on the reef flats.

### *Objective 4: Determine growth time of settled worms to market size.*

In October 2002, young feather duster worms (e.g., 1 mm in tube diameter) were obtained in waters surrounding HIMB. Approximately five individuals were placed into 15-gallon aquaria that received a continuous supply of seawater from Kaneohe Bay. There were four tanks in total that were set up for this trial. Over the course of the next three months, two of the aquaria received 1 L of *Chaetoceros,* which was cultured in the same fashion as used by shrimp hatcheries. Once each month, the tube diameters of the worms from all tanks were measured, and these were plotted against the length of time the worms were in the tank. The data clearly show that the fed group grew significantly faster than the ones that received only water directly from Kaneohe Bay. Apparently, feather duster worms can only utilize phytoplankton in their diet. The finding that the group fed only Kaneohe Bay seawater also grew during the same time period indicates that the minimum amount of food required to sustain feather duster worms is not very great.

*It was projected that it would take one year for settled worms to reach market size.*

Using the growth data from the worms that were being fed, a regression analysis yielded a statistical model that summarized the rate of growth. The model: $Y=(0.039)*Days$, $r^2 = 0.72$, $P<0.001$ can be used to estimate the amount of time that will result in an adult feather duster worm that has an average tube diameter of 10 mm. Substituting 10 mm for Y and solving for Days, we obtain 200 Days, which is the estimated time interval it would take a feather duster worm to reach a market size of a 10-mm tube diameter. The data indicate that the feather duster worms in culture (e.g., provided live food) grow at a rate at which they can be harvested within a year.

### *Objective 5: Summarize results in technical bulletins, newsletter articles, and where appropriate, manuscripts to be submitted to peer-reviewed journals for publication.*

Results of the larval development and feeding trials are being summarized in partial fulfillment of a Ph.D. dissertation by David Bybee. He is a graduate student in good standing in the University of Hawaii at Manoa's Department of Zoology. While no written manuals have been prepared, several presentations have been given locally and at international conferences.

## *Soft Coral*

### *Objective 1: Determine the appropriate type of substrate and water motion for culturing each target species. Also, determine any interaction effect from the two variables.*

The soft corals, like the feather duster worms, underwent an intensive quarantine process. After the quarantine process was completed, corals were placed in tanks that consisted of a 2,000-L oval raceway with seawater and air supply. Each coral tank had a different type of water motion. Tank 1 had a periodic surge motion created by two 110-L Carlson Surge Devices. Tank 2 had a semi-laminar flow created by two spray-bars at each end that could be angled to adjust the water velocity (note: the velocity of water was not monitored). Tank 3 had a static water motion with the same turnover rate as the other two tanks. This was created by two spray-bars spread out evenly over the entire raceway. The only change in the experimental design was a change in the regime and type of substrates tested for the corals. The new regimes were as follows:

| Species | Substrate 1 | Substrate 2 | Substrate 3 |
|---|---|---|---|
| *Protopalythoa* sp. | Gravel | Coral chips | Gravel mixed with sand |
| *Zoanthus pacifica* | Gravel | Coral chips | Lava chips (cinder) |
| *Zoanthus morgan* | Gravel | Coral chips | Lava chips (cinder) |

The substrates chosen were based on two different criteria. The first was the availability of the substrate, keeping in mind what is available and affordable for the commercial farmer. The second was growth patterns from the wild. For example, *Protopalythoa* sp. is found attached to rocks under the substrate (typically sand). The sand/substrate interface may be important to the asexual reproduction of this coral. This question will be answered with this experimental protocol.

With the completion of all construction, the animals were stocked into all experimental units. Each coral tank consisted of 90 individually labeled trays. Each species was tested with three substrates and ten replicates. The *Protopalythoa* trays had 3–5 polyps, while the *Zoanthus* species had 10–30 polyps due to their smaller size. One important note was that *Anthelia edmondsoni* was not stocked

into the experiment because not enough polyps were collected in time for the quarantine process. So, this species took a much smaller role in the project than originally proposed. However, as polyps were collected, they were integrated into the experiment.

Zoanthus sp. *grew remarkably faster than the other two species under all of the conditions.*

The experimental period extended between January 2003 and the end of April 2003. Interspecific variation as to the substrate and water motion conditions that would result in optimal growth could be detected. However, one species, *Zoanthus* sp. produced more polyps than the other species under any of the conditions tested. This result overshadowed the differences observed for a particular species. Growth for both *Protopalythoa* sp. and *Z. pacifica* may be inhibited by intense sunlight exposure, or these species may require an additional source of food besides light energy. Improvement in growth for both these species clearly requires further investigation and goes beyond the scope of this project.

### *Objective 2: Document baseline growth rates for each of the target species.*

Four months of data have been obtained. As mentioned previously, one clear result is that *Zoanthus* sp. clearly grew at a remarkable rate of approximately 20 polyps per month under all conditions and had reached a plateau by the end of the growth trial. The slowing of growth is attributed to the lack of space for additional polyps to grow because it had overgrown the test baskets.

### *Objective 3: Determine other critical variables that may contribute to optimal growth. This determination will be based on observations and experiences during the course of the first year.*

Because this portion of the project will not continue into Year 2, the growth experiment was terminated in April. During that time, the growth experiment became a grow-out trial where the polyps of *Z. morgan* were pooled and placed on lava cinders to conduct a mass grow-out. There were at least 10,000 polyps of *Z. morgan* that were ready to be shipped to Ocean Rider, Inc. in Kailua-Kona.

### *Objective 4: Determine preliminary marketability and crude economic feasibility information for the target species.*

Soft coral colonies were to be shipped to Ocean Rider, Inc., located in Kailua-Kona. They had agreed to take on the test marketing of the soft coral produced under the auspices of this project. A problem developed that has prevented the interisland shipping of the cultured soft corals from Oahu to Kona. Under the scientific collecting permit conditions, which the original stock of soft corals were collected, that original stock cannot be sold. There is a grey area as to whether the cultured soft corals are still part of the original stock because they reproduce asexually and are essentially a massive clone from the original stock. Likewise, the

Division of Aquatic Resources biologist (Dave Gulko) that has raised these issues also indicated that the species of the coral that has been in culture at OI needs to be clarified. In short, although there is sufficient biomass to start test marketing the cultured product, there are some bureaucratic issues that remain to be resolved for this activity to reach its full potential.

***Objective 5: Develop, in theory, a larger-scale prototype system that would incorporate the optimal conditions and growth information obtained during Year 1 and would also include any marketing information.***

Year 2 activities for this component were not supported by CTSA, and consequently, this objective was dropped from the project's work plan. The bulk of the activity will have to be developed by Ocean Rider, Inc.

## Impacts

Progress to date indicates that at least the feather duster worm and one species of soft coral can be developed for the marine ornamental trade. This will undoubtedly add to the inventory of enterprises engaged in the production of marine ornamentals. There are clearly some technical issues that remain to be resolved for the feather duster worm, and this is not the case with at least one soft coral species. For the soft coral, a non-technical constraint has emerged as an impediment and will need to be addressed before the full impact of the current project's work can be assessed.

## Publications in Print, Manuscripts, and Papers Presented

### *Presentations*

Bybee, D. 2003. Reproduction of the sabellid polychaete *Sabellastarte spectabilis* in Kaneohe Bay, Oahu, Hawaii. Albert Tester Student Symposium. April 16–17, 2003, Department of Zoology, University of Hawaii at Manoa.

Bybee, D.R., J.H.Bailey-Brock, and C.S. Tamaru. 2003. Observations on the spawning of the fan worm, *Sabellastarte spectabilis*, in Hawaii. Fifth Annual Hawaii Aquaculture Conference. May 11, 2003, Windward Community College, Kaneohe, Hawaii.

Bybee, D.R., J.H.Bailey-Brock, and C.S. Tamaru. 2003. Observations on the spawning of the fan worm, *Sabellastarte spectabilis*, in Hawaii. Page 132 *in* World Aquaculture 2003 Book of Abstracts. May 19–23, 2003, Salvador, Brazil.

Bybee, D.R., J.H. Bailey-Brock, and C.S. Tamaru. 2004. Gamete maturation and feeding in the fan worm, *Sabellastarte spectabilis*, in Kaneohe Bay Hawaii, USA. Page 27 *in* Marine Ornamentals '04 Book of Abstracts. March 1–4, 2004, Honolulu, Hawaii, USA.

Morgan, E., A.D. Montgomery, T. Ogawa, C.S. Tamaru, and D. Ziemann. 2004. The effect of water motion and substrate on growth of three species of zoanthids in Hawaii. Page 76 *in* Marine Ornamentals '04 Book of Abstracts. March 1–4, 2004, Honolulu, Hawaii, USA.