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REGIONAL NOTES

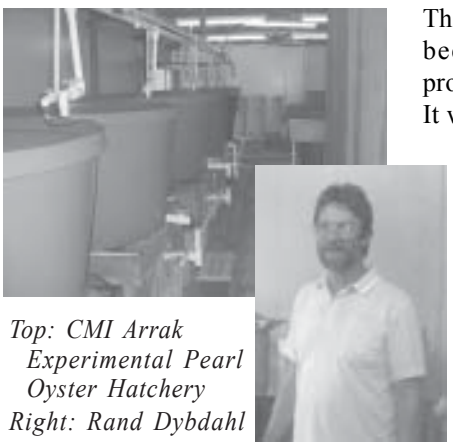
CENTER FOR TROPICAL AND SUBTROPICAL AQUACULTURE

CMI hatchery churns out black pearl oyster spat for industry

In July 2003, the Black Pearl Research Programme of the College of the Marshall Islands (CMI) gave a boost to the black pearl aquaculture industry in the Republic of the Marshall Islands (RMI) by successfully producing 1.07 million black-lip pearl oyster (*Pinctada margaritifera*) spat for distribution to two local companies. This is the first time in more than two years that spat have been produced and distributed to RMI farms. A hatchery run was conducted at the former Black Pearls of Micronesia (BPOM) hatchery at Woja in late August 2002; however, mass mortality of the larvae resulted in only a few hundred spat being produced.

The restoration of hatchery operations and the development of sustainable black-lip pearl oyster aquaculture in the RMI is an industry priority. In accordance with stakeholders' feedback, this became the primary objective for the Center for Tropical and Subtropical Aquaculture (CTSA) project "Aquaculture Extension and Training Support for the US-Affiliated Pacific Islands." The project's home base was moved from the College of Micronesia in Pohnpei to CMI in Majuro where its main focus has shifted from providing general extension services to stabilizing black-lip pearl oyster spat supply in the RMI. The project's principal investigators are pearl oyster hatchery specialist Rand Dybdahl and the CMI's Land Grant aquaculture research scientist Dr. Manoj Nair.

Dybdahl and Nair were responsible for conducting the successful hatchery run at the experimental pearl oyster hatchery at CMI's Arrak campus. This hatchery had initially been built in 2001 to propagate sea cucumbers. It was recently remodeled to accommodate the oysters. The remodeling was funded by the Asian Development Bank (ADB) Outer Islands Development Program, US Department of Agriculture (USDA) Initiative for Future Agriculture and Food Systems, USDA Hatch Formula Funds, and CTSA.



Top: CMI Arrak Experimental Pearl Oyster Hatchery Right: Rand Dybdahl

photos courtesy of Manoj Nair

(From L to R) Manoj Nair (CMI Land Grant), Virgil Alfred (BPOM), Tabwi Aine (Land Grant), Sebastian Horbushko (Robert Reimers Enterprises), and Rand Dybdahl (CMI)

The hatchery run lasted 45 days, beginning on June 1, 2003 and ending in mid-July. Dybdahl and Nair successfully spawned the oysters in captivity and reared the larvae in tanks until they were ready for distribution. Robert Reimers Enterprises and BPOM each received 357,000 spat ranging in size from 2-2.5mm. This was three times the amount initially requested. The remaining spat are being held at the CMI demonstration pearl farm in Arrak. These will be used for Nair's USDA Hatch Research and Development projects and for the newly proposed ADB-funded pearl farm in Jaluit.

Dybdahl is currently upgrading the commercial hatchery at Woja, now owned by the Marshall Islands Marine Resources Authority (MIMRA), which is where he and Nair plan to continue their work.

Continued on page 6

Letter from the director

At the beginning of September, CTSA officially opened its University of Hawaii (UH) offices. We would like to thank the College of Tropical Agriculture and Human Resources (CTAHR) for warmly welcoming us to the UH Manoa campus and providing us with office space and other support services. The CTSA administrative office will remain at the Oceanic Institute (OI), and we hope that having two locations will make us more accessible. We realize that OI's strict quarantine status may have made it difficult for some of you to visit us.

While my main office will still be at OI, I intend to spend at least one to two days a week at UH. Please continue to feel free to contact me at the OI office at (808) 259-3107 or cslee@oceanicinstitute.org. Detailed contact information for our two offices is listed on page seven. Our doors are open to you, and we welcome your input.

Cheng-Sheng Lee

REGIONAL NOTES

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AQUA CLIPS

DLNR holds statewide public meetings on Aquatic Invasive Species Draft Management Plan available for review

Department of Land and Natural Resources news release – Wednesday, July 9, 2003

HONOLULU – A state plan to minimize the harmful ecological and economic impacts of aquatic invasive species in Hawaii will be discussed at the remainder of a series of statewide public meetings this month. The draft "Aquatic Invasive Species (AIS) Management Plan," is a multi-agency effort being coordinated by The Nature Conservancy of Hawaii for the Department of Land and Natural Resources Division of Aquatic Resources. The purpose of the aquatic invasive species management plan is to prevent and manage their introduction, dispersal within, and from Hawaii. For a PDF copy of a draft version of the Aquatic Invasive Species Management Plan for the State of Hawaii, please visit www.state.hi.us/dlnr/dar/index. html. The draft plans will be reviewed by agencies and organizations within and outside of Hawaii, the Federal Aquatic Nuisance Species Task Force, and the public. For more information, contact: Andi Shluker, Project Coordinator at ashluker@tnc.org.

UH professor plans tuna farm

By Craig Gima, Honolulu Star Bulletin, Sunday, July 20, 2003

It would be like a ranch in the ocean. But instead of cattle, a University of Hawaii professor is hoping to raise and fatten ahi in the open ocean cages off the Waianae Coast. Ahi Aquaculture Farms is asking the state for permission to lease a portion of the ocean a mile offshore of Kepuhi Point and Maili Point. The company wants to place 18 cages about 660 feet in circumference and 50 to 60 feet deep in waters with a depth of about 100 feet. Each cage would hold up to 2,000 juvenile yellow tail and big eye tuna bought from local fishermen. The fish would be raised until they weigh about 100 pounds each and are ready for market. The company was granted state high technology tax credit under Act 221, allowing the project's local financial backers to claim 100 percent tax credit over five years on their investment.

Offshore fish farm closer to approval

By Karen Iwamoto, West Hawaii Today, Tuesday, July 29, 2003

A local aquaculture company wants to lease 81 acres of ocean for a deep sea fish farm located 2,000 feet offshore of Unualoha Point, north of Kona International Airport. Kona Blue Water Farms (KBWF), a division of Black Pearls Inc., wants to cultivate about 10,000 kahala per month in six submerged cages about 150 to 200 feet underwater. It also will raise a significantly smaller number of mahimahi in the cages, said Neil Anthony Sims, vice president and research director of Black Pearls Inc. The fish will be sold primarily to local restaurants and retailers. The Department of Land and Natural Resources found no significant impacts in KBWF's lease application Final Environmental Assessment. KBWF must also obtain a string of permits, including a Conservation District Use Application (CDUA), an Army Corps of Engineers (ACOE) permit and a Natural Pollutant Discharge Elimination System permit (NPDES), among others.

Reproductive physiologist to lead finfish research at the Oceanic Institute

The Oceanic Institute press release – Monday, August 25, 2003

The Oceanic Institute announces the promotion of Dr. Charles W. Laidley to Marine Finfish Program Manager. In this role Dr. Laidley will manage the Institute's groundbreaking research on the aquaculture of marine ornamental fish such as flame angelfish and yellow tang and food fish such as red snapper, amberjack, and bluefin trevally. Dr. Laidley succeeds Dr. Robin Shields, who has accepted a position with the University of Swansea in Swansea, southeast Wales, managing a new aquaculture research center.

Aquaculture is on the rise in American Samoa

Interest in aquaculture has grown considerably in American Samoa since 1997 when CTSA director Cheng-Sheng Lee last visited the territory. Lee spent July 31 to August 5, 2003 in American Samoa and was encouraged to see that there are now approximately 30 tilapia farms on the main island of Tutuila as compared to only one farm six years ago.

Farmers formed an American Samoa Tilapia Association led by president Alosina To'omalatai, which meets once a month. Members exchange information and help each other out.

American Samoa Tilapia Association members with Cheng-Sheng Lee (CTSA)

Farmers also have strong support from Congressman Eni Faleomavaega who recognized that "with a 12% unemployment rate and little infrastructure to support tourism, there is a critical need for creating industries that will be sustainable and compatible with traditional Samoan culture." On August 21, Congressman Faleomavaega announced that Sea Grant will provide $150,000 in federal funding to develop tilapia and ornamental clam aquaculture industries in American Samoa. A minimum of five workshops will be conducted through this project. Aquatic feeds and nutrition expert, Albert Tacon, will also be involved in the effort. Sea Grant Hawai'i already has one extension agent, Darren Okimoto, stationed in American Samoa.

CTSA seeks to partner with Sea Grant and its agent Okimoto in support of the growing aquaculture industry in American Samoa.

USDA APPROVED

CTSA received approval for its Year 16 Plan of Work. The projects approved thus far are:

- Pacific Regional Aquaculture Information Service for Education (PRAISE), Year 16
- Sturgeon Aquaculture in Hawaii, Year 2
- Marine Ornamentals Phase II – Techniques for Large-Scale Production of Pygmy Angelfish
- Economic Feasibility for Freshwater Ornamental Fish Growers in Hawaii to Market their Products Directly to West Coast Retailers
- Addressing Some Critical Bottlenecks to Commercially Viable Hatchery and Nursery Techniques for Black-lip Pearl Oyster Farming in Micronesia and Population Genetics of the Black-lip Pearl Oyster (*Pinctada margaritifera*)
- Disease Management in Hawaiian Aquaculture, Year 10
- Pacific Threadfin Fingerling Transport Technology Development
- Aquaculture of Hawaiian Marine Invertebrates for the Marine Ornamental Trade, Year 2
- Greater Amberjack (*Seriola dumerili*) Nursery Fingerling Production
- Postharvest Handling and Storage of Limu

Register early!

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www.hawaiiaquaculture.org/marineornamentals04.html

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AQUA TIPS

On the use of formulated diets during first feeding of larval freshwater ornamental fishes

Clyde S. Tamaru, Kathleen McGovern-Hopkins and Gavin Iwai

University of Hawaii Sea Grant College Program, Windward Community College Aquaculture Complex and Hawaii State Department of Agriculture Aquaculture Development Program

This article was written as part of the work for the project, "Transitioning Hawaii's Freshwater Ornamental Industry, Years 2 and 3" which was funded in part by the Center for Tropical and Subtropical Aquaculture under a grant from the US Department of Agriculture Cooperative State Research, Education, and Extension Service.

photos courtesy of Clyde Tamaru

Pterophyllum scalare

Introduction

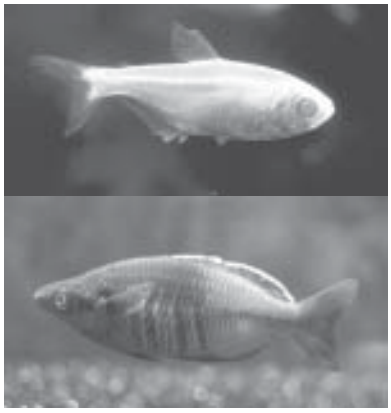
One of the goals of the project "Transitioning Hawaii's Freshwater Ornamental Fish Industry" is to develop hatchery protocols for as many kinds of freshwater fishes as possible. One major challenge has been to find a suitable kind of food for the first feeding larvae of the large variety of egg laying species that are present in the industry. Many of the egg layers produce larvae that have initial mouth sizes that are too small for brine shrimp nauplii, and alternative feeds need to be found. In addition, because of the variation in availability of *Artemia* cysts and its high price, decreasing the dependence on brine shrimp is also a desired outcome of the research activities.

Several criteria need to be met with any type of initial larval fish food, but chief among them are that they need to be: 1) cost effective 2) readily available and 3) in suitable quantities to handle thousands of first feeding larvae at one time. A common practice of many fish hobbyists is to use infusoria, which is kind of a soup (greenwater) of protozoans, mainly ciliates, as an initial live food source. For our purposes, we will also include multi-cellular organisms such as rotifers in the definition of infusoria. The recirculating systems that are present at the Windward Community College aquaculture complex provide for a readily available source of infusoria (or greenwater) and allows for investigating the rearing of tropical ornamental fishes with other commercially available diets.

Extensive research and development activities have already resulted in the availability of a number of artificial diets. Advantages for use of artificial diets are that they: 1) can be used readily, 2) can be easily stored, 3) consist of uniform particle size, and 3) consist of uniform nutritional quality. Artificial diets also lend themselves to being used in automated feeders which can substantially decrease the labor costs in large-scale production systems. The challenge, however, is that not all fish larvae will readily accept an artificial diet for a variety of reasons. Using a standardized experimental design and a single commercial diet (Encapsulon, Argent Chemical, Redmond, Washington, USA), the first task was to reveal which species of freshwater ornamental fish could utilize a particular commercial diet. The results of these trials form the basis for this report.

Materials and Methods

Six species of first feeding larvae (2-3 days posthatched) were obtained from a variety of resources, e.g., Mike Yamamoto (*Betta splendens*), Pat and Nancy Maloney (*Hemigrammus caudovittatus*), and Dudley Yogi (*Pterophyllum scalare*). Larval rearing experiments were conducted in 5 L black plastic pales with a working volume of 4 L. Each tank was equipped with an air stone and all of the tanks were placed in a water bath where the water temperature was maintained at 26ºC with aquarium heaters. All tanks were stocked with 20 larvae each (five larvae/L), and four feeding treatments were tested over the course of one week. The treatments were: 1) a no feed control, 2) greenwater (GW) only, 3) greenwater plus 12.5 ppm Encapsulon II (GW + Feed) and 4) 25 ppm Encapsulon II only. All treatments were conducted in triplicate. Encapsulon II (150-250 mm) was purchased from Argent Chemical Company (Redmond, Washington, USA), and the use of their product does not constitute an endorsement. To maintain consistent water quality conditions, 1 L of the volume of each tank (20%) was removed



Top: Hemigrammus caudovittatus
Bottom: Melanotaenia boesemani

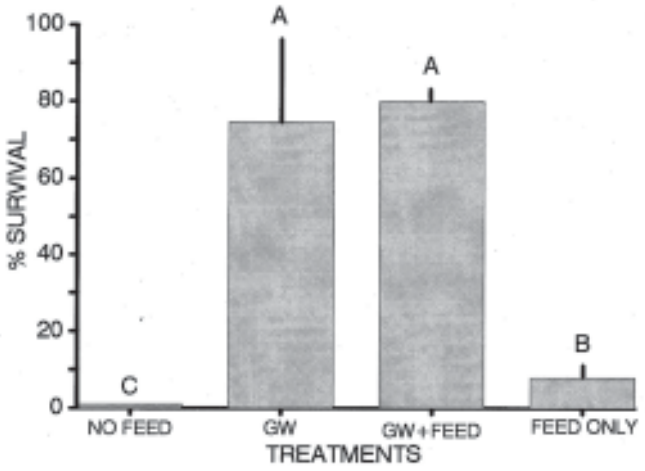


FIGURE 1. *Percent survival of Siamese fighting fish larvae fed various food treatments. Bars are the standard deviations from triplicate determinations and values that do not share the same alphabet are significantly different (P<0.05) from each other.*

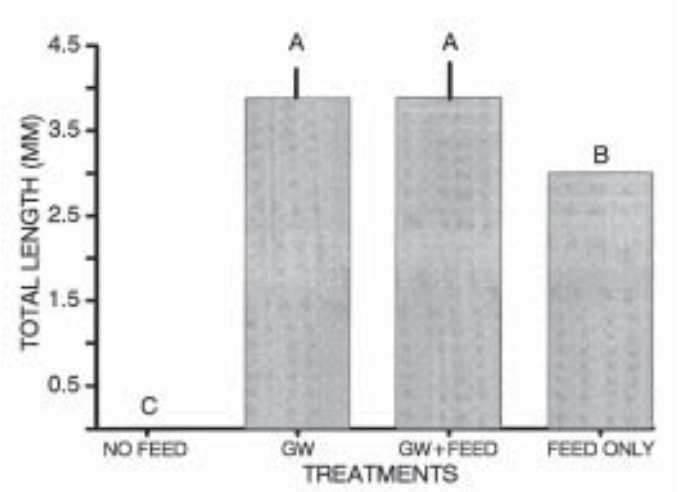


FIGURE 2. *Total length of Siamese fighting fish larvae fed various food treatments. Bars are the standard deviations from triplicate determinations and values that do not share the same alphabet are significantly different (P<0.05) from each other.*

each day and replaced with the appropriate amount of greenwater or freshwater. Water temperature, dissolved oxygen and pH were determined daily. The criteria for terminating the experiment was that there were either little or no surviving larvae in the no food treatment which usually took place between the 6th or 7th day post-hatching. Larvae that were still surviving in the other treatments were doing so because of the food that was available to them. On the day the experiment ended, all of the surviving larvae were counted from each rearing tank and then preserved in a 1% formalin in seawater solution. Total body length for the larvae was determined at a later date using a dissecting microscope equipped with an ocular micrometer. All results were then statistically analyzed using one-way analysis of variance to detect differences in response to the various treatments.

Results and Discussion

An example of the results obtained from a rearing trial using the Siamese fighting fish, *Betta splendens*, is presented in Figures 1 and 2 (e.g., survival and total body length, respectively). Average survival amongst the treatments that utilized greenwater were found to be relatively high (average survival for greenwater: 74.7% ± 21.7% and for greenwater + Encapsulon: 80.1% ± 3.3%). There was no statistical difference that could be detected between the greenwater and greenwater + Encapsulon treatments. The average survival of the Encapsulon only treatment was significantly ($p<0.05$) lower than the treatments with greenwater. The actual number of surviving larvae in the Encapsulon only tanks ranged between 1-3 larvae per tank. The low survival indicates that the artificial diet alone cannot support first feeding fighting fish larvae. The average total lengths of the fishes found in the various treatments are summarized in Figure 2. There are no detectable differences between the greenwater and greenwater + Encapsulon feeding treatments. The surviving larvae that were found in the Encapsulon only treatment were found to be significantly smaller than the other treatments. The smaller size larvae found in the Encapsulon only treatment is consistent with the poor survival that was observed for the same treatment. Such results would indicate that Encapsulon alone is not suitable as an initial feed for Siamese fighting fish larvae.

The results obtained for the other species that were examined are summarized in Table 1. The response of a particular species to a particular feeding regimen is ranked as follows: - = poor, * = average, ** = good, *** = excellent. In addition to the Siamese fighting fish larvae, both the Buenos Aires tetra and angelfish larvae could not utilize the artificial diet when presented alone as an initial food item. In contrast, three other species investigated (Bosemani rainbows, rainbow sharks, and redtail sharks) were found to be able to utilize the artificial diet to varying degrees. For example, Bosemani rainbowfish were found to be able to utilize Encapsulon alone as an initial food source if the results were only based on survival. However, the resulting fish larvae from the feed only treatment were found to be significantly ($p<0.05$) smaller than those presented a greenwater or greenwater + Encapsulon feeding

TABLE 1. *Summary of first feeding larval rearing experiments using greenwater and/or Encapsulon. See text for explanation of symbols.*

Species	Common Name	Green Water	Green Water + Encapsulon	Encapsulon Only
Betta splendens	Siamese Fighting Fish	**	**	-
Pterophyllum scalare	Angels	**	**	-
Melanotaenia boesemani	Bosemani Rainbow	**	***	*
Hemigrammus caudovittatus	Buenos Aires Tetra	**	**	-
Epalzeorhynchos bicolor	Redtail Shark	*	*	***
Epalzeorhynchos erythrurus	Rainbow Shark	*	*	***

Continued on page 7

CMI hatchery cont'd from page 1

This successful hatchery run was due to the cooperation of several people and organizations for which sincere thanks and gratitude are expressed.

Mr. Mark Canney
Ministry of Education ADB Project for Outer Island Development

Mrs. Diane Myazoe, Dean
Land Grant

Mr. Don Hess, Dean/Chair
Liberal Arts Department/Marine Science Program
College of the Marshall Islands

Mr. Danny Wase, Director
Marshall Islands Marine Resources Authority (MIMRA)

Mr. Ramsey Reimers, **Ms. Jessica Reimers**, **Mr. Nobert Reimers**
Ramsey Reimers Enterprises (RRE)

Mr. Bobby Muller and **Mr. Virgil Alfred**
Black Pearls of Micronesia

Dr. Cheng-Sheng Lee
Center for Tropical and Subtropical Aquaculture

Dr. Singeo Singeru, **Mr. Masahiro Ito**
College of Micronesia Land Grant

Mr. Simon Ellis
Pohnpei Conservation Society

Dr. Maria Haws
University of Hawaii at Hilo

Mr. Neil Sims, **Mr. Dave Wise**
Black Pearls, Inc.

Mr. Karl Fellenius
Marine Science Program, College of the Marshall Islands

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Mr. Tabwi Aine, Research Aid
Land Grant

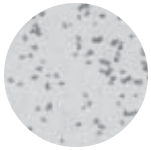
Mr. Jimity, **Mr. Peter**, Research Assistants
College of the Marshall Islands

Mr. Timothy, **Mr. Laywer**, Research Assistants
Marshall Islands Marine Resources Authority (MIMRA)

Mr. David Debrum, **Mr. Sam Annam**
College of the Marshall Islands Physical Plant

Special thanks to **Mr. Frankie Pedro** of the RRE pearl farm in Arno for risking his life in a small boat late at night to deliver the crucially needed broodstock to Majuro.

From hatchery to lagoon…



Day 45 (2-2.5mm) attached spat

1 Dr. Manoj Nair and Peter Langneo remove attached spat from 200 L settlement tanks with a paint brush and gently flowing seawater.

2 Nair and Langneo transfer pearl oyster spat collected on 360 micron mesh sieves to 750 micron mesh paint bags. They used a piece of PVC pipe as a spreader and as protection for the spat. It also acted as a substrate for spat attachment.

3 Three spat-filled paint bags were placed in 1.75 mm mesh bags and hung inside 750 L tanks to slowly acclimate them to raw sea water. The process takes 7-9 days.

4 The carefully packed spat were placed into clean coolers half full of fresh 25 micron-filtered raw seawater and taken to the dock for the final leg of their journey.

5 The coolers were loaded onto a boat for a 3-4 hour trip to the farm sites. Frequent water exchanges were conducted throughout the trip.

UPDATE

CTSA opens new offices at UH:

CTSA is jointly administered by the Oceanic Institute and the University of Hawai'i, and there are now offices at both sites to better serve the industry:

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CTSA Year 17 proposals in the process of being reviewed:

CTSA sent out twelve proposals for external review in mid-September. Reviews are expected to be completed by late October. Selected proposals will make up the CTSA Year 17 Plan of Work.

CTSA director visits the US Virgin Islands:

CTSA director Cheng-Sheng Lee spent July 13-19, 2003 in the US Virgin Islands learning about the University of the Virgin Islands' (UVI) aquaponics technology. Aquaponics is an integration of aquaculture and hydroponics. Lee met with aquaculture program director James Rakocy of the UVI Agriculture Experiment Station to discuss this efficient production system. While the US Virgin Islands are included in the Southern Regional Aquaculture Center, it has much in common with the CTSA region, such as a subtropical climate and island nature.

CTSA director attends project meetings in the Marshall Islands and Guam:

CTSA director Cheng-Sheng Lee took time to follow up on two projects. Lee went to Majuro, the Marshall Islands, from August 7-9, 2003, to meet with stakeholders regarding the Pacific islands extension project. Lee congratulated project principal investigators Rand Dybdahl and Manoj Nair on their successful hatchery run. The group then discussed how to continue moving forward by taking advantage of this progress. Lee then went to Guam from August 10-12 to check the status of the tilapia project which had encountered some initial setbacks due to the December 2002 supertyphoon Pongsona.

Formulated diets cont'd from page 5

regimen. This would indicate that although the larvae will accept the artificial diet as an initial food item, it is not the best diet for them at this stage of development. Interestingly, Bosemani rainbowfish larvae exhibited significantly ($P<0.05$) higher percent survival when provided the combination of greenwater + Encapsulon. This indicates the green water infusoria can be augmented by the addition of the artificial feed, and the combination of both may be the most suitable initial food strategy for initial feeding of this species. Both the rainbow and redtail shark larvae were found to be able to utilize the artificial diet as an initial food item. It should be emphasized that the artificial diet can be used as a stand alone initial first feed for both species as indicated by the significantly higher percent survival obtained when it is used alone.

Epalzeorhynchos erythrurus

All of the results combined indicate that there is a wide amount of variability in the ability of a freshwater ornamental fish species to be able to utilize an artificial diet as an initial food item. Clearly some cannot, some can to some extent, and for some, it appears that it may be even superior for use in a hatchery setting. The experimental design used in the current report clearly provides a suitable method for screening which species can accept an artificial diet as an initial feed. Such experiments will continue in order to identify species that can or cannot utilize an artificial diet as an initial feed item. Such information has great practical value in the overall designing of hatchery operations and outputs. However, understanding the reasons why a particular species can and cannot use an artificial diet is equally important and is clearly an area that requires further investigation.

Acknowledgements

The authors wish to thank Pat and Nancy Maloney, Dudley Yogi, and Mike Yamamoto for their generous donation of larvae to the project. The activities presented were partially supported by a grant from the USDA's Center for Tropical and Subtropical Aquaculture titled, Transitioning Hawaii's Freshwater Tropical Ornamental Fish Industry, Years 2 and 3," the University of Hawaii Sea Grant College Program, and the State Department of Agriculture Aquaculture Development Program. The views expressed herein are those of the authors and not of the funding agencies and collaborative institutions.

CENTER FOR TROPICAL AND SUBTROPICAL AQUACULTURE

The Center for Tropical and Subtropical Aquaculture (CTSA) is one of five regional aquaculture centers in the United States established by Congress in 1986 to support research, development, demonstration and extension education to enhance viable and profitable US aquaculture. Funded by an annual grant from the US Department of Agriculture's Cooperative State Research, Education and Extension Service (USDA/CSREES), the centers integrate individual and institutional expertise and resources in support of commercial aquaculture development.

CTSA currently assists aquaculture development in the region that includes Hawaii and the US-affiliated Pacific islands (American Samoa, Commonwealth of the Northern Mariana Islands, Federated States of Micronesia, Guam, Republic of Belau [Palau] and the Republic of the Marshall Islands.)

In its fifteen years of operation, CTSA has distributed over $7 million to fund more than 161 projects addressing a variety of national aquaculture priorities.

FAST FACT

"The US ranks as the third largest consumer of seafood in the world, importing 76 percent of its seafood fare."

--UN Food and Agriculture Organization

Each year, the Center works closely with industry representatives to identify priorities that reflect the needs of the aquaculture industry. After consultation with appropriate technical experts, CTSA responds with a program of directed research with objectives that focus on these industry priorities. A Board of Directors is responsible for overseeing the programmatic functions of CTSA. Results of CTSA projects are disseminated through its print publications, hands-on training workshops, and Web site.

CTSA is jointly administered by The Oceanic Institute and the University of Hawaii and its main office is located at The Oceanic Institute's Makapuu Point site on the island of Oahu in Hawaii.

For further information, contact Cheng-Sheng Lee, Ph.D., Director, by phone (808-259-3107), fax (808-259-8395) or email at cslee@oceanicinstitute.org.

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