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The Oceanic Institute and the University of Hawaii
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REGIONAL NOTES
CENTER FOR TROPICAL AND SUBTROPICAL AQUACULTURE

Aquaculture of marine ornamentals moves forward

Photo courtesy of The Oceanic Institute

The demand for marine ornamentals has been steadily rising from the increased interest of aquarium enthusiasts. With an estimated 5% of the supply being aquacultured, Hawaiian reefs currently supply a hefty portion of the world's marine ornamental fish. The second year of the CTSA project, *Aquaculture of Marine Ornamentals*, combines the skilled research background of scientists from The Oceanic Institute (OI) and the Waikiki Aquarium to lessen the world's reliance on wild-caught ornamentals and assist in the diversification of the state's economy by researching the culture of marine ornamental species with difficult-to-rear larvae. More specifically, the project will address the the two key bottlenecks in the culture of marine ornamentals – reproduction and first-feeding. The Aquarium's component will focus expressly on the larvae's consumption of zooplankton.

As reported in a previous *Regional Notes* (Vol. 12 No. 2), the project working group at OI, with additional funding support from the National Marine Fisheries Service, had established broodstock populations for both the yellow tang (*Zebrasoma flavescens*) and the flame angelfish (*Centropyge loriculus*) and obtained successful captive spawning for the flame angelfish. Although the OI group was able to achieve spawns for the yellow tang, the eggs were initially all infertile. However, OI has recently accomplished isolated spawns with fertility rates up to 88% and fecundity has increased 100 fold. They are also now able to identify and separate the sexes based on external characteristics. The yellow tang was found to be sexually dimorphic with males identified by the presence of a bristle patch along the caudal peduncle. Additionally, the OI group has demonstrated the existence of a lunar rhythm in the spawning activity. Initial diet trials were conducted with the larvae that resulted from some of the spawns in an attempt to compare various live food organisms as first feeds for yellow tang. Further work on this element is planned, as survival past Day 5 was so low that the experiment could not continue.

Future activities planned for the OI component of this project will examine the usefulness of hormones to induce spawning in yellow tang. Researchers originally thought hormones would be needed to induce spawning but having achieved success without them, they still feel hormone induction will enable them to stimulate reproductive maturation and increase spawn fertility. OI also anticipates developing an egg disinfection protocol for small marine ornamental eggs. The Aquarium has completed certification required by the University of Hawaii's Institutional Animal Care and Use Committee and will begin work shortly.

CTSA Call for Concepts

Once again, CTSA is initiating the start of its proposal process. As we did last year, we are asking first for submissions of concepts. The purpose of the concept submission is to give you, those involved in tropical and subtropical aquaculture, a chance to voice the problems that you are having and would like CTSA to address. Your concerns will then be forwarded to the Industry Advisory Council. If you are having problems, this could be the way to get them solved. Send your submission to CTSA by January 31, 2001 by email at kawaya@oceanicinstitute.org or fax (808) 259-8395 or mail to CTSA, The Oceanic Institute, 41-202 Kalanianaole Hwy., Waimanalo, HI 96795.

Letter from the director

Twice a year I attend a meeting of the National Coordinating Council (NCC), comprised of the five Regional Aquaculture Center (RAC) Directors and National Aquaculture program leaders. An industry representative from each region joined the NCC in our most recent meeting in November. We were pleased to see that by using a multi-institutional approach, the RACs have all made significant contributions to the development of aquaculture in each region since funding started 15 years ago. The problem has become that although we continue to strive to affect the industry positively, it is becoming increasingly difficult to address all the issues from the industry because funding for each RAC has remained level for the past 15 years. With inflation, the funding we receive today essentially amounts to approximately 60% of the funding power the RACs had enjoyed in the early years. As we have in the past, we continually work toward establishing collaborative relationships with other funding agencies to ensure that we remain 100% effective for the industry. We must keep on working together to address the needs of the industry and to continue promoting the growth of a sustainable aquaculture industry in our region. So, please make sure to tell us what you in the industry, need to strengthen your operations to become the thriving industry we know we are capable of creating.

Cheng-Sheng Lee

REGIONAL NOTES

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AQUACLIPS

Study to look into fish farm possibilities

By Scott Radaway, Pacific Daily News - Tuesday, August 14, 2001

The Guam Economic Development Authority has received three proposals from businesses wanting to conduct a salmon and rainbow trout farming feasibility study, said Leigh Lujan, GEDA's industry development manager. The agency will choose one firm and begin negotiations within a month, she added. At the same time, a group of Norwegian investors continues to study the island as a possible site for a salmon farm, Lujan said. The proposed Norwegian fish farm could employ as many as 150 people, GEDA officials have said. As well, the export of salmon from Guam might create additional shipping lines for Guam's fishing companies, Lujan said.

Canadian firm may grow halibut for Japan market

By Prabha Natarajan, Pacific Business News - September 7, 2001

A Canadian company wants to grown Atlantic halibut for Japan's sushi market on the Big Island. Unlimited Halibut Corp. of Vancouver, B.C., is working with the Natural Energy Laboratory of Hawaii, and has secured preliminary approval from the state Department of Agriculture to grow halibut as an experiment. Halibut thrives in the cold waters of the north Atlantic and Pacific oceans. Scotian halibut [partner company] has rights to technology developed in Iceland to commercially grow halibut larva into juveniles. The Hawaii operation initially will grow juveniles brought in from the East Coast. [The company] plans to harvest them at 10 pounds. It takes two years to grow juveniles.

Uh-Hilo aquaculture center to open next year

By Hugh Clark, The Honolulu Advertiser - Sunday, September 9, 2001

The centerpiece of the $7 million Pacific Aquaculture and Coast Resources Center will be two 80-foot diameter sludge digester tanks that will be converted into 400,000-gallon fish tanks. The [12.5 acre complex] will be in operation next year, serving the university's agriculture and marine sciences department and UH-Manoa's Sea Grant Program. The purpose of the center is to demonstrate and test possible marine crops, including shrimp, tilapia, exotic fish and various algae.

Big island aquaculture firm receives $1.5 million grant

By Terrence Sing, Pacific Busisness News - October 19, 2001

Big Island-based Kona Blue Water Farms has received a $1.5 million federal grant to develop a live-feed system for marine fish larvae. A subsidiary of Black Pearls Inc., the company plans to use the money to grow the zooplankton needed to feed deep-water, bottom-dwelling species with higher market value, such as onaga, ehu, opakapaka and hapuupuu.

Oceanic raises funding to develop disease-free shrimp

By Prabha Natarajan, Pacific Business News - November 16, 2001

A joint venture led by Oceanic Institute received an $8.2 million federal grant to develop a commercial disease-free shrimp production system. The U.S. Department of Commerce National Institute of Standards and Advanced Technology Program will fund nearly 50 percent of a $16.6 million, five-year shrimp reserach project. Other companies in the venture are Kahuku Shrimp Co., PIC USA Inc. in Berkeley, [CA] and Zeigler Bros. of Gardners, [PA], which will fund the rest of the project in exchange for intellectual property and commercialization rights. Last year the company developed Bisecure Zero-Exchange Shrimp Technology (BioZest) that will serve as the prototype for the project. BoZest offers a "green water system" for growing shrimp, [Tom] Farewell [president and CEO of OI] says. The system operates in a closed microbial environment with disease-free shrimp, water and feed. The system, [OI's] research indicates, results in faster shrimp production with lower costs. [OI] projects a 65 percent profitability rate with three crops a year and a yield of one pound per square foot of shrimp pond.

New publication available

Best Management Practices for Hawaiian Aquaculture, CTSA Publication #148 by Dr. Robert Howerton, Sea Grant Extension Agent, is now available.

The publication is a result of the CTSA project with the same title. It is a useful resource for those just getting started in aquaculture, as well as those more seasoned farmers wanting an excellent manual for reference.

Best Management Practices is available for download at http://library.kcc.hawaii.edu/CTSA/pubs/html. Limited hard copies are also available by contacting Alcian Clegg by email at aclegg@oceanicinstitute.org or by phone at (808) 259-8168.

HAA Membership Meeting

Calling all current and prospective HAA members!! This meeting is for anyone who wants to help the aquaculture industry in Hawaii grow.

The annual Hawaii Aquaculture Association meeting will be held January 19, 2001 at the Bishop Museum. For more information contact Dean Toda at (808) 587-0030 or aquacult@aloha.com.

The aquaculture industry must have a political presence and a voice in the debates over improvement of the economy. A strong industry association can serve that purpose to the benefit of everyone in the aquaculture community.

INTERNSHIPS AVAILABLE

The Micronesia and American Samoa Student Internship Program and the University of Hawaii Hawaiian Internship Program are accepting applications for their Summer 2002 internship programs. Application deadline is **February 1, 2002**. More information and forms are available for download from www.soest.hawaii.edu/SEAGRANT/internship. Interested host agencies can contact Sharon Ziegler-Chong at (808) 933-0706 or by email at ziegler@hawaii.edu

Aquatic Microbiologist/Microbial Ecologist Needed

Description: Aquatic Microbiologist / Microbial Ecologist at the Research Scientist level to conduct research on the contribution and aquatic microorganisms in intensive aquaculture systems.

Responsibilities: Successful candidate will undertake research on the role played by aquatic autotrophic and heterotrophic microorganisms as a potential source of nutrients in shrimp production systems and larval fish culture systems, and develop techniques for monitoring and exploiting microbial contributions from feed and feed ingredients in those systems. Preparation of project proposals and reports, and generation of publications for peer-reviewed scientific journals, is required. Position may also require outdoor work, exposure to sunlight, working with chemicals, temporary extended off-site work, and flexible work hours.

Qualifications: Ph.D. in microbiology/microbial ecology with proven research experience and publication record in aquatic and/or feed microbiology. Strong background in data handling and analysis and writing skills. Position is available immediately.

Application Instructions: Send application letter with CV, research experience, record of publications, and names of three professional references by mail or e-mail to: The Oceanic Institute, Attn: Personnel, 41-202 Kalanianaole Hwy., Waimanalo, HI 96795 USA E-mail: mkapuakela@oceanicinstitute.org

AQUA TIPS

Establishment and growth of cell lines from aquacultured fish in Hawaii for diagnosis and isolation of pathogenic viruses

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This article was written as part of the work for the project titled "Disease Management for Hawaiian Aquaculture, Year 7," which was funded in part by the Center for Tropical and Subtropical Aquaculture under a grant from the U. S. Department of Agriculture Cooperative State Research, Education, and Extension Service.

Introduction

The aquaculture of freshwater ornamental fish, food fish, marine fish and shrimp has received increased attention for commercial development in recent years in Hawaii. Disease losses have traditionally been high in some groups of fish, particularly those that are emerging species of importance. One potential problem threatening the continued expansion of aquaculture in Hawaii is infectious diseases, specifically those caused by pathogenic viruses. Increasingly, new diseases of probable viral origin have been growing in groups of marine fish and ornamental freshwater fish imported into Hawaii causing severe losses. These new viral diseases threaten existing fish-farming industries in the state. Recent examples include high mortalities of cultured guppies due to a putative viral infection of the liver and a pernicious form of gill disease that affected imported batches of juvenile koi.

Viruses are known to be important pathogens to many species of aquacultured fish and often cause mass mortality of affected species. Unlike other microorganisms, which can be readily grown in artificial nutrient medium, viruses are obligatory intracellular pathogens and their isolation and propagation are totally dependent on the availability of a live host, such as permissive cell cultures. In addition, most viruses are host-specific and tissue-specific, and they can only be isolated and propagated using cell cultures established from tissues of the same host species.

In addition, trends in case submissions indicate a pressing need for fish diagnostic virology for aquaculture producers in the State of Hawaii. A susceptible cell culture system is the most important laboratory tool to grow, isolate and characterize, and identify new viruses for the detection of pathogenic fish viruses. However, cell lines currently do not exist for most of the marine and freshwater ornamental fish undergoing aquaculture development in Hawaii. The lack of appropriate cell culture systems hinders the development of preventive strategies for viral diseases and the inspection of batches of juvenile fish for health classification. Thus, appropriate cell lines necessary for the cultivation and isolation of pathogenic viruses from aquaculturally important fish species in Hawaii need to be developed. These cell cultures will become an essential first line of defense for the detection and surveillance of pathogenic fish viruses and will be important to the fish health assurance program of the aquaculture industry in Hawaii.

In this report, we describe our initial attempts at establishing *in vitro* cell cultures from different species of fish that are economically important to Hawaiian aquaculture for the diagnosis and study of pathogenic fish viruses.

Materials and Methods

Fish Sources and Treatment

Four species of fish were used in this study, including goldfish (*Carassius auratus*), grey mullet (*Mugil cephalus*), green swordtail (*Xiphophorus helleri*) and angelfish (*Pterophyllum scalare*). Young-aged fishes that appeared healthy were collected. Prior to the experiment, donor fish were disinfected with diluted bleach, and then rinsed with 70% alcohol.

Growth Media

Several amino acid-enriched commercially available media for animal cell cultures, including minimum essential medium (MEM), Medium 199, Leibozitz-15 (L-15) and RPMI-1640, were used to support initial growth of fish cells. Media were supplemented with 20% fetal bovine serum (FBS) and various antibiotics, such as penicillin (200 U/ml), streptomycin (200 µg/ml), gentamicin (50 µg/ml) and amphotericin B (5.0 µg/ml).

Organ and Tissue Selection

Two external tissues and selected internal organs were obtained from donor fish using aseptic techniques. Fins, snout, head soft muscle, kidney and spleen were excised in succession from donor

fish and immersed immediately in antibiotic incubation medium (AIM), containing 5x concentrated antibiotics compared to the growth media, prior to cultivation (Lu et al. 1990).

Primary Cell Culture

Following incubation in AIM for 2 hours, tissue/organ specimens were minced into 1-2 mm pieces using sharp sterile scalpels. Primary cell cultures were initiated using the explant method (Wolf 1976, Lu et al. 2000) in that approximately 20 fragments of each tissue were seeded uniformly into Primaria-brand 25-cm^2 tissue culture flasks. Following 2-hour attachment, tissue pieces were fed with 5 ml of growth medium supplemented with serum and antibiotics. The cultures were incubated at appropriate temperature (20-28°C) and cell growth was monitored daily for the appearance of newly formed cell colonies and increased size using phase-contrast microscopy.

Subculture and Passage

After the formation of confluent cell monolayer, tissue fragments were dislodged from the flasks. The monolayered cells were harvested using 0.25% trypsin solution, and resuspended in fresh medium plus filter-sterilized conditioned medium. The cell suspension was distributed into two flasks. Subsequent subcultures were performed every 7-10 days at a cell-split ratio of 1:2 to 1:3. Culture medium was changed weekly using 40% conditioned medium and 60% fresh medium. Beginning at passage 5, conditioned medium was not included in further subculturing and the concentrations of serum and antibiotics were halved after 10 passages (Lu et al. 1990).

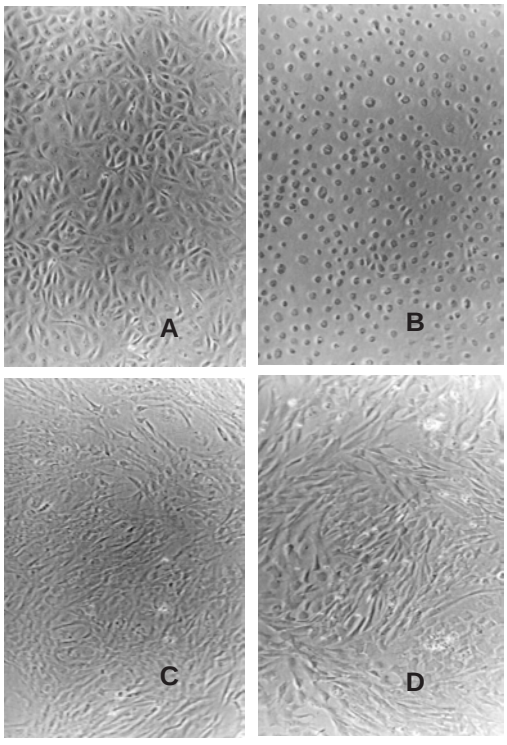

Figure 1. Morphology of cell lines established from fins of mullet (A), green swordtail (B), angelfish (C) and from head soft muscle of angelfish (D). Magnification: 150x

Cell Line*	Morphology	# of Passages
GFCF	fibroplastic	10
GFSN	epithelial	8
AFCF	fibroplastic	13
AFSN	epithelial	15
AFM	fibroplastic/ epithelial	9
GSSN	epithelial	3
GSCF	epithelial	8
MTSN	epithelial	1
MTCF	fibroplastic	1
MTKD	epithelial	1
MTSP	fibroplastic	1

* GF = Goldfish, AF = angel fish, GS = green swordtail, MT = mullet; CF = caudal fin, SN = snout, M = muscle, KD = kidney; SP = spleen

Table 1.

Cryopreservation

Fish cells at the logrithmic growth phase were harvested using 0.25% trypsin solution. Following low-speed centrifugation, cell pellets were resuspended in cell-freezing medium containing 20% FBS and 10% DMSO and dispensed into 1-ml plastic vials. Vials were stored at –70°C for 24 hours in a cryogenic controlled-rate freezing container and then transferred in liquid nitrogen for long-term storage.

Results and Discussions

Since the initial attempts at establishing cell lines from aquacultured fish in Hawaii, we have developed an *in vitro* cell culture protocol for successful establishment and cultivation of cells from different species of fish commercially important in Hawaii.

We have established primary cell cultures from all four fish species in our initial trial. As shown in Table 1, primary cell cultures derived from goldfish, angelfish and green swordtail exhibited active growth kinetics and these cells have been subcultured up to 13 times since their initiation in August 1999. By contrast, cells derived from grey mullet grew very slowly and were not successfully subcultured.

A comparison of the initial growth of different tissues from the four fish species was conducted. Our preliminary data showed that fin and snout tissues were readily cultivated while kidney, spleen and heart were difficult to grow. It is an advantage to establish cell cultures from external tissues since fins and snout tissues are more accessible for sampling. However, it should be noted that external

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"Growing the business" in Micronesia

By C. L. Cheshire

This is an excerpt taken with permission from a report written by Dr. C.L. Cheshire entitled "Business, Family and Business Development in Micronesia" based on Dr. Cheshire's personal interactions with business owners and leaders in Micronesia. Dr. Cheshire is the Senior Business Development Manager for the Pacific Business Center Program at the University of Hawaii at Manoa.

There are several obvious advantages to starting small in Micronesia, but starting small does not mean that a business owner in Micronesia can only look forward to having a small operation. Several of the business owners that I spoke to started small, but their businesses are now quite large, demonstrating that it is possible to grow a large business on a small island. But, growing a large business on a small remote island in Micronesia is not easy. In many ways it is analogous to trying to make water run uphill due to the many barriers that limit business growth in the Western Pacific.

A business owner in Micronesia who focuses on the local market is limited because the local market is very small. Regardless of what the product or service is, the market is soon saturated. The only exception to this that I am aware of is betelnut, and here the limiting factor is not demand, but supply.

If the business is a small export business, it is difficult, if not impossible, to expand it gradually because the existing transportation system cannot accommodate gradual growth. Continental Airlines, the only air carrier in the FSM, has limited cargo space which is not always available even for small volume shippers. PM&O, the only surface carrier for parts of the FSM requires that the shipper ship in container loads. A twenty -foot container holds twenty thousand to thirty thousand pounds which has to be full or almost full before the per pound shipping costs are economical.

Going from a couple of thousand pounds per shipment to twenty to thirty thousand pounds is a big leap and it cannot be accomplished without radically changing the structure and the nature of the business. In other words, the difference between a small exporter and a large exporter in Micronesia is more than size. They are two different businesses requiring different personnel, different facilities, different infrastructure and different markets and buyers.

The FSM governments, both the National and the State governments, have tried to address the problem of size by financing the start-up and operation of several large fishery (fresh tuna) and agricultural (coconut soap) ventures. None of these operations, however, has ever been turned into a self-supporting, profitable business. They exist more as government departments, run by government appointed managers and dependent on the government for some form of subsidy, than they do as independent businesses.

The business owners that I spoke to told me that the solution to the problem of small island markets is not large scale export businesses but diversification into an array of related goods and services. Some of the following examples have already been mentioned, but it is useful to list them here to show how diversified some of these businesses are:

- One business owner went from a travel agency and car rental to a multi-unit apartment building, to a twenty-five room hotel and restaurant. They have recently added a bar, and a dive shop is planned for future expansion.
- Another business owner went from selling cigarettes out of the back of a van to a general retail clothing store, to a hardware store, to a construction company, to developing land for a multi-unit housing complex.
- Yet another business went from stevedoring , to construction, to sand dredging and concrete blocks, to a hardware store, to propane distribution.

Several other examples could be added; diversified businesses are so common in Micronesia their existence hardly needs to be pointed out. What is not fully appreciated is how large some of these businesses are. Some have monthly gross sales in the hundreds of thousands of dollars. Of course, these same businesses have comparably high monthly expenses, but even if their net profit is only five to ten percent, they are making profits of several thousand dollars every month. The other measure of a company's size, number of employees, is also impressive. Some of these same diversified companies have between fifty and one hundred people working for them.

Successful diversification in Micronesia follows two basic rules or principles. First, diversification works only if the initial core business is successful. The business owners I spoke to said their core business was initially quite successful and provided the capital for further expansion. Second, diversification is most effective as a growth strategy when the business diversifies into businesses that complement and enhance the competitiveness of the core business. For example, a construction business is complemented by the ownership of a hardware store. For one business owner in Micronesia there was a similar complementary relationship between construction, commercial buildings and commercial businesses. The business owner, who owned a small construction company, used his employees and equipment (when he did not have a contract to build a building for someone else) to build a commercial building for himself with spaces for small storefronts on the ground floor and rooms for rental apartments and hotel rooms on the second floor. Some of the storefronts he rented to local businesses, but some of them he kept for himself to use to open his own businesses. The upstairs apartments and rooms he rented out to construction crews and business travelers.

Diversification can give the Micronesian business owner a significant advantage over his local competitors since it is relatively inexpensive for him to use the personnel, equipment and facilities of the core business to start and operate an array of other businesses. This advantage is easy to see when one compares a general retail business (which is, in effect, a specialized — one product — retail business that has diversified into several products) with a specialized retail business. If a new specialized retail business opens and introduces a new product, it does so at a significant cost and

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Cell lines cont'd

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tissues had a higher risk of bacterial and fungi contamination and thus it is necessary to decontaminate the external surface of donor fish before tissue sampling (Wolf 1979). We have found that diluted bleach together with 70% alcohol were effective in reducing microbial contamination while not affecting the viability of the cells.

Morphological examination of newly established fish cell cultures indicated that except for cell cultures derived from angelfish head soft muscle showing a mixed morphology, which contained both epithelial- and fibroblastic-like cells (Figure 1), other cell cultures appeared either epithelial-like or fibroblastic-like (Table 1, Figure 1).

Several media were employed in the initiation of primary cultivation of these fish cells. Although all of these different media supported cell growth, Medium 199 and L-15 medium appeared superior to the other two for initiating primary growth of fish cells (data not shown).

These cell lines are currently being characterized in terms of their optimal growth conditions (growth temperature, serum requirement and CO_2 content), chromosomal number, plating efficiency and susceptibility to viruses isolated from fish and other aquatic animals according to previously described methods (Early 1975, Freshney 1994, Lu et al. 2000). The cells will be used for the isolation and propagation of viruses that affect these fish species.

In addition, we are currently establishing cell cultures from other species of fish cultured in Hawaii, including clownfish (*Amphiprion ocellaris*), sea horse (*Hippocampus erectus*), awa (*Chanos chanos*), snakehead (*Channa striatus*) and moi (*Polydactylus sexfilis*). Once these cell cultures and cell lines are established, they will be essential to the success of the Hawaiian aquaculture industry. Cell cultures can vary greatly in their sensitivities to different viruses. If a virus is inoculated into an insensitive cell culture, the virus will not be able to replicate and a negative result will be obtained. When small amounts of virus are present in a specimen such as an early viral infection, a positive result may be obtained only when the most sensitive cell culture system is used. Therefore, successful establishment of cell lines from various fish economically important to Hawaii aquaculture will improve diagnosis of viral disease and prevention and also facilitate an improved quality control program for live fish shipment.

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Business cont'd

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risk. If the new business is successful, all the general retail business owner must do is clear some room on his shelves to add the same product. In most cases, the general retail business is not required to find a building to operate out of, nor does it need to add employees or equipment to sell the new product. As a result, his overhead costs (the costs involved in selling a product other than the cost of the product itself) for selling the new product are almost nothing compared to the overhead costs of a specialized retail business.

If the situation is reversed and the diversified general retail business wants to introduce a new product, the same advantage applies. Unlike his one product competition, a diversified business owner can afford to experiment with the introduction of new services and products with little risk or fear of competition because his costs to introduce a new product or service are so low compared to the costs of his non-diversified competitors. In many instances, the diversified business does not need to borrow money or take on investors either of which can be a major additional cost to the business. Because its costs relative to its competitors are so low, a diversified, general retail business can afford to sell a new product at the lowest possible price and still make a profit. Consequently, it is very hard for anyone to compete with them.

Proposal process update

On October 9-10, 2001, CTSA's Technical Committee met for its annual meeting at the East-West Center in Honolulu, Hawaii. Representatives from research, education, and extension institutions traveled to discuss the 13 proposals submitted to CTSA for Year 15 funding consideration. Project work groups were then given specific issues to address in their revised proposals due back in mid-November. CTSA is currently reviewing the revised proposals and will be taking them to the Project Review Delegation meeting on December 11, 2001 at The Oceanic Institute. From there the proposals will be compiled and submitted to the Board of Directors as the Plan of Work with recommendations for each individual proposal. Upon their endorsement, CTSA will forward the Fifteenth Annual Plan of Work to the U.S. Department of Agriculture for approval.

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 U.S. aquaculture. Funded by an annual grant from the U.S. 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 U.S. 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 thirteen years of operation, CTSA has distributed $7 million to fund more than 130 projects addressing a variety of national aquaculture priorities.

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 is located at The Oceanic Institute's Makapuu Point site on the island of Oahu in Hawaii.

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

FAST FACT

The value of Hawaii aquaculture production totaled $22.2 million in 2000, up 22 percent from 1999

-- State of Hawaii Aquaculture Development Program

CENTER FOR TROPICAL AND SUBTROPICAL AQUACULTURE

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