CENTER FOR TROPICAL AND SUBTROPICAL AQUACULTURE

Regional Notes

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The Oceanic Institute and the University of Hawaii
41-202 Kalanianaole Highway, Waimanalo, HI 96795

Water chemistry tests reviewed...see page 4

Thanks to PRAISE for 11 years of service

For eleven years, the Pacific Regional Aquaculture Information Service for Education (PRAISE) has been working to fulfill its motto, "to get the right information to the right place at the right time." As PRAISE begins its twelfth year, the service will continue to provide free information to a diverse group of users on a wide range of marine science topics.

Since 1988, CTSA has provided a portion of the funding for PRAISE, an aquaculture workstation operated and managed by the staff of Hamilton Library at the University of Hawaii. The service subscribes to a number of databases, including Aquatic Science and Fisheries Abstracts (ASFA), Agricola, and Biological Abstracts. These databases list articles on aquaculture topics from hundreds of scientific journals. The PRAISE staff performs literature searches on request using these and other databases. Search results are provided in the form of a listing of citations and abstracts. Depending on the nature of the search and the number of citations found, results may be returned via postal mail, email, fax, or computer disk. (All computer files are in ASCII format.)

The last eleven years have seen many advances in the services provided by PRAISE. From its implementation in 1990 of CD-ROM-based searches, to the launch of its own Web site in 1995, PRAISE continues to work to provide access to timely scientific information. Everyone from aquaculture farmers to researchers to college students has benefited from the service.

Internet users can access a variety of information at PRAISE's home page at *http://lama.kcc.hawaii.edu/praise*. Records indicate that users from around the world access the site nearly 6,000 times each month. The site offers a vast amount of aquaculture information, including a news section, the latest aquatic health information, legislative updates, listings of Pacific vendors, employment opportunities, upcoming conferences, a gray literature bibliography, and internet links to a variety of related Web sites—including CTSA's. You can also request a literature search directly from the Web site.

A recent addition to PRAISE allows the University of Hawaii community to conduct their own ASFA searches at no charge by accessing the Cambridge Scientific Abstracts Web site through the library at *http://www.hawaii.edu/sciref*. For those who do not use the UH ITS as their internet service provider, PRAISE has two remote sites on Oahu; one at the CTSA Administrative Offices at the Oceanic Institute, and another at the Cooperative Extension Service office in Wahiawa.

You don't have to be a computer wizard to take advantage of the PRAISE service. Search requests will be filled even if they arrive via mail, fax, phone, or walk-in. Contact Kristen Anderson, PRAISE coordinator at:

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Science and Technology Dept.
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Honolulu, Hawaii 96822
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Whether it's information on guppies or gouramis, shrimp or sponges, PRAISE has been working for more than a decade to provide valuable and timely scientific information to the aquaculture community in the Pacific Region—and beyond.

NADA coordinator launches Web site

Obtaining the latest information on approvals for new animal drugs that have applications in aquaculture just got easier thanks to the launch of the National New Animal Drug Applications (NADA) Coordinator Web site at *http://ag.ansc.purdue.edu/aquanic/jsa/Aquadrugs.htm*. Since 1995, CTSA has provided a portion of the annual funding needed to conduct the NADA project.

The site, which is located at the Joint Subcommittee on Aquaculture's homepage, was established by the USDA to provide information on the goals, objectives, background, current position, international activities, and progress reports of the National NADA Coordinator. The site also provides a convenient email link to contact NADA coordinator Rosalie Schnick with questions or input regarding project activities.

A recent tour of the site revealed a wealth of information, much of it found in Schnick's *Fourth Annual Report of Activities*. Status updates were included for a long list of various drug applications such as amoxicillin, Chloramine-T, formalin, hydrogen peroxide, and many others. Additional activity highlights included reports on several workshops attended by Schnick. A bibliography of Schnick's publications, manuscripts, special reports, and presentations is also provided.

The overall goal of the National NADA Coordinator project is to coordinate activities for investigational new animal drug exemptions (INADs) and new animal drug applications (NADAs) to expedite approval for the use of various drugs in aquaculture.

In May, CTSA received the USDA "stamp of approval" on its Year 12 Plan of Work. The USDA commented that the plan was "well-written and builds on previous activities supported by CTSA." Projects began on June 1 in a variety of areas designed to meet the needs and concerns of commercial aquaculture in the CTSA region.

New committee members

Since their appointment in January 1999, the newest members of the CTSA Industry Advisory Council and the Technical Committee have been busy with their new responsibilities. Whether attending the annual committee meetings or reviewing proposals, their diverse backgrounds and wide range of expertise have already contributed greatly to the CTSA program. CTSA welcomes its new members and looks forward to working with them during their three-year term.

New Industry Advisory Council Members

- Michael Bauerlein, Special Project Coordinator
  Guam Aquaculture Development & Training Center
- Dr. Paul Bienfang, Senior Vice President
  CEATECH USA Inc. (Hawaii)
- Rebecca Bishop-Yuen, Co-owner
  Palaau Prawn and Shrimp Company (Hawaii)
- Yimnang Golbuu, Researcher
  Palau Community College
- Robert Kern, Owner
  Tropical Ponds of Hawaii
- Dr. Todd Lorenz, Scientific Director
  Cyanotech (Hawaii)
- Toshiuki Rudolph, Chief Magistrate
  Kukuoro Municipal Government (FSM)

New Technical Committee Members

- Dr. Brad Argue, Geneticist
  The Oceanic Institute (Hawaii)
- Dr. Albert Tacon, Nutritionist
  The Oceanic Institute (Hawaii)

CTSA Regional Notes

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Extension agent provides free assistance to region

Since 1989, CTSA has provided funding for an aquaculture extension specialist for the U.S.-Affiliated Pacific Islands.

Simon Ellis, the extension specialist since January 1997, has provided helpful, free assistance to many island residents on a wide variety of aquaculture ventures. His service region includes the Federated States of Micronesia, American Samoa, the Commonwealth of the Northern Mariana Islands, the Republic of the Marshall Islands, and the Republic of Belau.

Ellis has recently published a CTSA Aquafarmer Information Sheet with valuable tips for those interested in culturing giant clams. CTSA Publication Number 139, *Lagoon Farming of Giant Clams (Bivalvia: Tridacnidae)* provides important details on the steps needed to become a successful clam farmer. The publication can be downloaded in Adobe Acrobat format from the CTSA home page at *http://library.kcc.hawaii.edu/CTSA*. Or you may request a copy while supplies last by contacting Alcian Clegg at the CTSA Administrative Center by phone (808) 259-3168, by fax (808) 259-8395, or by email at *aclegg@teligentmail.com*.

Ellis is currently working on a publication (with an accompanying video) that has already generated a lot of interest. CTSA Publication Number 137, *Soft Coral Culture Manual*, will be available in November.

In addition to developing a variety of aquaculture publications, Ellis also supports the region with site visits to as many islands as possible. His upcoming travel schedule (subject to change) follows:

August 30 - September 11
Majuro & Jaluit, RMI
September 21 - 24
Pohnpei, FSM (pearl oyster shellcraft workshop)
September 27 - October 8
Saipan and Rota, CNMI
October 25 - November 6
American Samoa

Ellis can be contacted by phone (691) 320-2728, fax (691) 320-2726, email (*sellis@mail.fm*) or by writing him at:

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AQUATIPS

Selecting products for water chemistry testing for your aquaculture operation

By Dee Montgomery, Hawaii State Aquaculture Development Program
and James Brock, D.V.M., Hawaii State Aquaculture Development Program

This article was written as part of the work completed for the project "Disease Management for Hawaiian Aquaculture," which is funded 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.

The maintenance of good water quality is important for every person who raises aquatic animals—from the large-scale aquaculture producer to the home hobbyist. Test kits or instruments are essential because the culturist needs to understand the quality of the environment surrounding their aquatic animals. Tests must be performed in order to measure the concentration of various water chemistry parameters.

To a large extent, which water chemistry parameter to measure depends on the features of the water system. For example, the periodic measurement of ammonia, nitrite, nitrate, and pH are important for closed or semi-closed recirculating water systems that rely on biological filtration for the processing of the metabolic waste (ammonia) excreted by the aquatic animals. On the other hand, culturists who use tap water may need to check the chlorine concentration before filling their tanks.

There are a variety of chemical tests and instrument systems currently available to culturists for the measurement of water chemistry parameters. The detection sensitivity needed, costs, and time required are several elements to consider when deciding on the type of kit or instrument appropriate for a given situation. An estimate of the number of tests to be carried out will also influence the choice of the measurement system.

The following *Aquatips* reviews several criteria that can be applied to the evaluation of water chemistry test products. Four chemistry factors (chlorine, total ammonia, nitrite/nitrate, and pH) and three test systems (strips, color discs, and a color meter) made by the same manufacturers were selected to use as examples.

The test strip technology relies on a visible color change that results from a chemical reaction between the water chemistry factor and the reagent chemicals imbedded on a plastic strip. For the color disc the chemical reaction between water factors and the reagents occurs in a test vial and the resulting color change is compared visually against a standard. Both the strip and the color disc technology are based on a color change viewed with the naked eye. The color meter applies a light-sensitive sensor to measure the chemical reaction in a test vial containing the chemical reagents and water sample. The measurement result is read from a digital display.

Measurement sensitivity

The sensitivity required for the measurement is the most important element to consider when selecting a water chemistry test method. The evaluation of a test product cannot occur without prior knowledge of the detection sensitivity appropriate for the application. Table 1 reports the analysis sensitivity results for the three test products for each of the four chemical factors. A detailed description and analysis of the results for each chemical factor follows.

Table 1. A comparison of the sensitivity of detection in mg/L for three test systems

Test System	Chlorine	Total Ammonia	Nitrite / Nitrate	pH
Strips	0.5	NA[1]	0.15 / 1	1
Color Disc	0.1	0.1	0.01 / 1	0.1
Color Meter	0.01	0.01	0.01 / 1	NA[1]

1. A test for this chemistry factor is not available for this system.

Chlorine

Chlorine does not occur naturally in water, but is often added to drinking water to kill harmful microorganisms. The use of tap water poses a potential chlorine health risk to aquatic animals because chlorine is highly toxic to gill breathing aquatic animals, even at concentrations as low as 0.1 mg/L. Indeed, for warmwater aquatic organisms, the safe level for long-term exposure is 0.001 mg/L for total chlorine. For warmwater fish, the five day LC_{50} concentration is 0.09 to 0.3 mg/L (Anon., 1976). Newly spawned eggs of warmwater fish may be more sensitive to chlorine than older life stages. Even for short periods, exposure of fish to chlorine at a concentration above 0.5 mg/L is detrimental and probably lethal for many species.

Because chlorine is toxic to aquatic species even at low concentrations, a sensitive analysis system is needed. Of the three test systems evaluated, only the color meter provides adequate sensitivity (0.01 mg/L) for chlorine measurement for aquatic animal health. As a general safety guideline, culturists should hold and aerate tap water at least 12 hours prior to use with aquatic animals.

Ammonia

Soluble ammonia is a byproduct of aquatic animal metabolism. In flow-through water systems with a reasonable biomass of aquatic animals and exchange of water, the ammonia is flushed out with the discharged water. However, in culture systems that rely on biological filtration (bacterial metabolism) for processing ammonia, a disruption of the microbial community can lead to the accumulation of ammonia or nitrite to levels that are toxic to aquatic animals.

In water, the soluble ammonia exists as two ionic states in a dissociation equilibrium. These two states of ammonia are the toxic un-ionized (NH_3) and the non-toxic ionized (NH_4^+) forms. For a given concentration of total ammonia ($NH_3 + NH_4^+$), the pH and the temperature of the water primarily determine the distribution of these two forms of ammonia. For example, in a total ammonia concentration of 3.5 mg/L at 25°C and pH 7.0, the amount of NH_3 is 0.02 mg/L. However, the same level of NH_3 (0.02 mg/L) is also found in 0.13 mg/L total ammonia when the temperature is 25°C but the pH increases to 8.5 [Anon., 1976].

The amount of NH_3 in the culture water is the most important factor to address in order to avoid adverse health effects to aquatic animals. For warmwater fish, the safe prolonged exposure level of NH_3 is 0.02 mg/L. Since the concentration of NH_3 is a fraction of the total ammonia, determining the concentration of total ammonia to the nearest 0.1 mg/L also provides adequate sensitivity for most culture applications. In this case, the concentration of NH_3 is then determined using tables that convert total ammonia to NH_3 (a calculation of the ammonia, pH, and temperature data). Culturists should become familiar with these conversion tables, which are available in most water quality textbooks.

Both the color disc and the color meter systems have minimum detection sensitivities of at least 0.1 mg/L and are therefore suitable for measuring ammonia concentrations for warmwater freshwater fish health.

Nitrite/Nitrate

Nitrite is an intermediate and nitrate the final product in the biological nitrification of ammonia. Nitrite is moderately toxic to gill breathing aquatic animals mainly due to its affinity to bind to hemoglobin to form methemoglobinemia which blocks the transport of oxygen in the blood. Nitrite below 0.1 mg/L is probably safe for prolonged exposure in warmwater freshwater fish. In comparison, nitrate is relatively non-toxic to aquatic animals. Prolonged exposure to concentrations up to 50 mg/L is probably tolerable for most warmwater aquatic animals.

Analytical sensitivity of 0.1 mg/L nitrite and 1 mg/L nitrate are adequate for purposes of maintenance of aquatic animal health. On the basis of sensitivity, either the test strips, the color disc, or the color meter systems could be used for nitrite/nitrate measurement for warmwater fish health.

pH

pH is a measurement of the activity and concentration of hydrogen ions and is an important factor in the regulation of biological and chemical systems. Warmwater aquatic animals can generally tolerate a wide range of pH, given the animals have adequate time to adjust to the change in the pH. Safe criteria for pH is given at 6.5 to 9.0 for most warmwater aquatic species (Anon., 1976).

For pH, we rely upon a sensitivity of 0.1 pH units as adequate for testing samples from culture systems with warmwater species. There are numerous portable or benchtop pH meters available on the market today. The majority of these instruments are suitable for pH measurement applications for warmwater aquatic animals. The test strip measurement for pH lacks adequate sensitivity, but the color disc system is suitable. The color meter system evaluated does not have a pH test function.

continued on page 6

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Instrument costs

A second criteria for the evaluation of water chemistry test products is the cost for the instruments (see Table 2). The three test systems rely on different instruments. In general, the higher the sensitivity of the analysis procedure, the more costly the instrumentation.

Table 2. A comparison of the approximate cost for instruments or special equipment for three test systems

Test System	Instrumentation	Test Discs or Modules	Approximate Total
Strips	0	0	0
Color Disc	0	$40-$80 per disc	$231
Color Meter	$500	$40 per module	$620

Test strips do not require any instruments. Likewise, there are no instruments for the color disc system, but a different disc is needed for each chemistry factor. The prices vary, but for the type used in this evaluation, the discs ranged in cost from $40 to $80 for each of the four chemical factors. The total cost was $231 to measure the four chemistry factors with the color disc system. The cost for the color meter was approximately $500 with the additional expense of $40 for each module needed to measure the three chemical factors tested (a pH test was not available for this system).

Reagent costs

A third criteria used in the evaluation was an estimate of the approximate cost of reagents per test for the three test systems (see Table 3). Breaking down the cost for water testing for different systems provides important information, especially if the user anticipates carrying out the measurement on a frequent basis.

Table 3. A comparison of the approximate cost per test for the reagents for the three test systems

Test System	Chlorine	Total Ammonia	Nitrite / Nitrate	pH
Strips	$0.20	NA[1]	$0.60	$0.18
Color Disc	$0.43	$0.12	$0.13 / $0.15	$0.05
Color Meter	$0.13	$0.13	$0.22 / $0.19	NA[1]

1. A test for this chemistry factor is not available for this system.

For most of the tests, the reagent costs range from $0.10 to $0.20 per test. The expense for nitrite and nitrate analysis is an exception, with the cost for the strip being about $0.60 per test. If nitrite/nitrate levels were measured weekly in the water from 10 tanks, the cost for the strips in a year would be $312. Reagent costs for testing done with the color disc would be $145.

Test completion time

A fourth criteria used to evaluate the three test systems was the approximate time needed to complete a single test. As shown in Table 4, the test strips were the fastest. Similar times to complete the test were found for most of the chemistry factors for the color disc and color meter, with the exception of the test for total ammonia, where the color meter test could be completed in one third the time. This would have important implications when analyzing a large number of water samples.

Table 4. A comparison of the approximate time in minutes needed to complete one test for the three test systems

Test System	Chlorine	Total Ammonia	Nitrite / Nitrate	pH
Strips	1	NA[1]	1 / 1	1
Color Disc	1	10	10 / 3	1
Color Meter	3	3	10 / 5	NA[1]

1. A test for this chemistry factor is not available for this system.

Summary

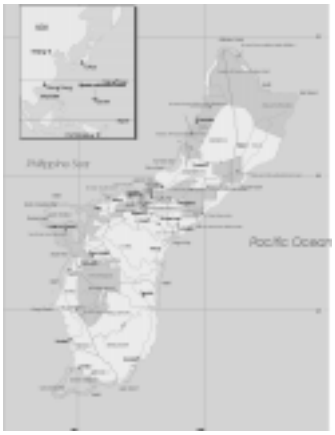
The detection sensitivity required, the cost for instruments and reagents, and the time needed to complete the test should all be considered when selecting a test system for the measurement of water chemistry factors important for aquatic animal health. This analysis indicated that test strips may not be the best choice for aquatic animal health monitoring due to their inadequate detection sensitivity. Color discs provide reasonable detection sensitivity for most applications, chlorine measurement being an exception. In all cases, basic knowledge of water chemistry will help the culturist understand and interpret the analysis findings.

References

Anon. 1976. U.S. EPA Quality Criteria for Water, Washington, D.C. US Government Printing Office, 256 p.

Guam project encourages aquaculture

Guam has advantages that make aquaculture a potentially significant industry for the island. The island's tropical climate facilitates the culture of a variety of species. In addition, Guam's large number of Japanese tourists provides a ready market for aquaculture products.



In 1973, the government set up aquaculture demonstration ponds at Talofolo where a number of species were tested, including eels and the Malaysian giant prawn. The Guam Aquaculture Development and Training Center has also cultured other species on a small scale, including soft-shell turtle, ornamental marine fish, mangrove crabs, and rabbitfish. Commercial farmers currently produce tilapia, milkfish (for food and bait), marine shrimp, Asian catfish, and Chinese and common carp.

However, despite these successes, Guam's complex permitting process sometimes discourages aquaculturists from starting a farm or expanding an existing operation. The CTSA funded project, "Public Policy Impact on Aquaculture Development in Guam" was developed to directly address this concern. The project, initiated under CTSA's ninth annual plan of work, focused on identifying government policies that may hinder the expansion of Guam's aquaculture industry. The project also provided aquaculturists with up-to-date information on the permitting process.

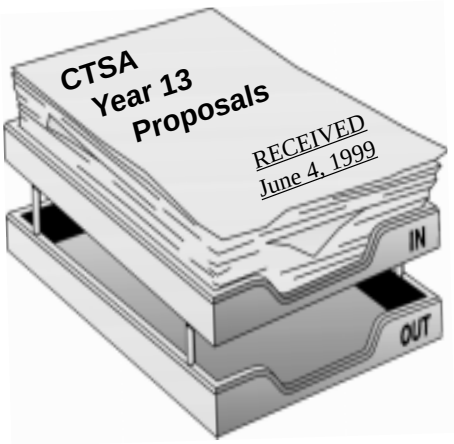
A two-day workshop was conducted that provided aquaculturists with information on how and when to acquire a permit. In addition, the workshop provided a forum to discuss proposed improvements to streamline the regulatory process. More than 150 people attended the workshop, including the governor, several senators, local and federal agency representatives, and existing and potential aquaculturists.

To further assist aquaculturists, 400 copies of the publication, *Aquaculture on Guam: Prospects, Permits and Assistance*, was published and distributed under the auspices of the Agricultural Experiment Station of the University of Guam. The project also produced a video, *Aquaculture on Guam*, which is available for lending to those seeking assistance in starting a farm.

The project's activities attracted the attention of the local media, and stories covering the workshop appeared in local newspapers and on television stations. The project's activities also prompted a visit by the governor to the Guam Aquaculture Development and Training Center (GADTC), resulting in identification of additional funding for the facility.

For more information on Guam's permitting process, or to borrow a copy of the project's video, call John W. Brown, Ph.D., at the University of Guam at (671)735-2100 or contact him via email at *jbrown@uog9.uog.edu*.

Update on year 13 proposals



The summer has been filled with CTSA Year 13 proposal activities. Nine proposals were received by the June 4 deadline and forwarded to 56 internal and external reviewers for their comments.

In July, conference calls were held with 24 internal reviewers whose suggestions were then forwarded to the various project work groups to incorporate into their proposals.

In September, the Program Review Delegation will meet for one last review of the proposals and to provide any further comments to the project work groups. The final proposals will be incorporated into the Year 13 Plan of Work for presentation to the CTSA Board of Directors in October. Once approved by the board, the Plan of Work will be submitted to the USDA for approval.

Many thanks to all of the internal and external reviewers for their support. CTSA depends on its reviewers' feedback to help develop projects that address the most important needs of aquaculture in the region.

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 the U.S. Department of Agriculture, the centers integrate individual and institutional expertise and resources in support of commercial aquaculture development. CTSA was established in 1986 and is jointly administered by The Oceanic Institute and the University of Hawaii. The CTSA offices and staff are located at The Oceanic Institute's Makapu'u Point site on windward Oahu. A Board of Directors is responsible for overseeing the programmatic functions of CTSA.

The mission of CTSA is to support aquaculture research, development, demonstration and extension education to enhance viable and profitable U.S. aquaculture. Unlike the other centers, which work within a defined geographical region, the CTSA "region" encompasses tropical and subtropical species wherever they are cultured. Research projects span the American Insular Pacific, using its extensive resource base to meet the needs and concerns of the tropical aquaculture industry.

Each year's program is developed by CTSA's Industry Advisory Council and Technical Committee, reflecting the Center's mix of commercial and scientific expertise. Council members represent financial institutions, aquaculture and agriculture enterprises, government agencies, and other business concerns. The Technical Committee includes researchers, extension agents, and fisheries officers. Both committees include representatives from American Samoa, the Commonwealth of the Northern Mariana Islands, the Federated States of Micronesia, Guam, Hawaii, the Republic of Belau, and the Republic of the Marshall Islands. For further information on the CTSA program, contact Cheng-Sheng Lee, Ph.D., Executive Director, by phone **(808) 259-3107,** by fax at **(808) 259-8395** or by email at **clee@teligentmail.com.**

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