AQUATIC & FISHERY SCIENCES

Newsletter of the School of Aquatic & Fishery Sciences University of Washington Spring 2002

SPRING

Inside

http://fish.washington.edu

In recent issues of our newsletter, we focused on the activities in the school coincident with the new millennium, including the new school facility, ongoing curriculum improvements, and a bumper crop of new faculty. Since 1999, we have added seven new faculty; our newest member, Lorenz Hauser, who will specialize in molecular ecology, arrived in April. Accordingly, we feature Lorenz in this issue.

We are particularly excited about the international background of several of our new faculty—the perspectives and experience derived from diverse countries as Austria, Canada, South Africa, and Zimbabwe will be an asset to our program. And, with Hauser's addition, we now have four faculty in the Marine Molecular Biotechnology Lab—including Kerry Naish of SAFS, and Ginger Ambrust and Gabrielle Rocap from Oceanography. With this "critical mass," we believe the Lab is poised to develop a truly outstanding molecular program.

Research at Aquatic & Fishery Sciences encompasses subject matter ranging from the molecular level to "charismatic megafauna" such as whales and other marine mammals, as well as a host of fish species, including salmon. With the tremendous advances in molecular and other techniques, research at the microscopic scale is gaining prominence.

In particular, Professor Russell Herwig and his students are pursuing several projects focused on issues surrounding microscopic organisms: From a study on oyster and geoduck disease, to an investigation of high-pressure water to eradicate disease-causing organisms in seafood, to research on methods to reduce exotic species introductions from ship ballast water, all these projects contribute to an ever-expanding and increasingly important perspective of the world of microbiology. Having featured "macrofauna" to a large extent in past issues, we felt it timely to feature developments at the other end of the spectrum.

Many of our students continue to benefit from the generosity of our alumni and friends, and they have expressed their gratitude in written form. We share some of the comments they've written in appreciation of their benefactors, and add our own heartfelt appreciation to all of you who have supported our students through private giving.

Last, but by no means least, we are pleased to feature our latest acquisition to the UW Fish Collection: the reclusive Pacific giant squid. This creature has been somewhat of a celebrity, having attracted numerous visitors on and off campus to see this intriguing specimen prior to its being accessioned to the Collection.

—Marcus Duke, Editor


Jake Perrin


Robyn Estes


Russ Herwig


Cindy Marshall


Lorenz Hauser

SQUID IN COLLEGE

The UW Fish Collection has a brand new member—a Pacific giant squid, measuring over 12.5 feet. It was caught by halibut fishermen in the Gulf of Alaska, frozen, and sent by plane to Seattle where SAFS faculty Ted Pietsch accessioned it.

A colleague of Ted's, Alan Kohn (Emeritus Professor from UW Zoology), has only seen three other specimens of this kind of squid, which can grow up to 30 feet in length. This specimen of *Moroteuthis robusta* has a 4-foot body with eight arms 3 feet in length and two 8-foot feeding tentacles, which are studded with sharp hooks of chiton for grasping prey. Ted treated a class of marine biology undergraduates to a viewing and discussion of the squid.

The Pacific giant squid may actually not be very scarce, but because it is so reclusive, it engenders many questions about life history, feeding habits, and reproduction.

Boat owner Kevin Kambak and his crew were working about 60 miles off shore from Yakutat, in water that was between 2,300 and 3,000 feet deep, when they caught the squid. The fishers gutted and iced the squid, thinking it might be edible but it proved too large and tough. Kambak made the squid available for community members to view, and then for display at schools, after which he shipped it to Seattle.

Dwina Howey of Sitka, the daughter of a fisheries biologist who recognized the possible research value in this squid, was the one who contacted Pietsch. After being a visitor at all the local schools, she says, "Now our squid will get a college education."

M. Levin, UW Photography #ML20020260_16a

Ted Pietsch and Alan Kohn examining giant squid at the UW Fish Collection

ENDOWMENTS *thank you*

Endowments are lasting legacies to their donors and a permanent source of financial support for students. In many cases, undergraduate and graduate studies would not be possible without the longstanding generosity of these endowments. The funding enables some students to pursue their basic academic programs and others to undertake special projects.

Our students routinely correspond with their benefactors to express their appreciation and to inform them about their academic pursuits. The following excerpted highlights represent the sentiments of the many SAFS students who have received financial assistance from endowments.

Egtvedt Fund (*Mrs. Evelyn Egtvedt*)

Lucie Weis (*B. Miller, advisor*): I would like to express my gratitude for your generous gift. Your contribution is allowing me to acquire an advanced degree in an excellent graduate program. I now have the opportunity to [study] the early life history of marine fishes and possible implications for conservation.

Dorothy T. Gilbert Endowed Ichthyology Research Fund (*Mrs. Dorothy T. Gilbert*)

Duane Stevenson (*T. Pietsch, advisor*)
The Gilbert Endowment has [given] me great opportunities, including visits to foreign collections in Japan, Russia, Austria, and England. [It] allowed me to finalize a manuscript now in press, and finish my degree. I have never had to worry about the financial support required to complete my research. For that I am deeply grateful to you. I hope the support you provide is as rewarding for you as it is for the students to whom you are so important.

Erin Macdonald (*T. Pietsch, advisor*)
I have benefited greatly from your kind donations to our laboratory. A three-month fellowship through [your] fund enabled me to spend Summer Quarter 2000 concentrating on my research, studying the larvae of prickleback fishes. I extend my sincere thanks for the opportunities you have provided that have helped tremendously in allowing us to become better scientists.

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FOCUS ON NEW FACULTY

M. Duke

Lorenz Hauser

Assistant Professor

PhD, University of North Wales, Swansea, 1996

Specialties: genetics and morphology of native and introduced populations of the Lake Tanganyika sardine

Lorenz is a native of Vienna, Austria. His education includes MSc's earned at University of Vienna and the University of North Wales, Bangor. After earning his PhD at the University of Wales, Swansea, he took a post-doc at the University of Hull (UK). Lorenz considers species introductions to be his overriding interest throughout his education and research.

You started out studying fish biology?

At the University of Vienna, I studied fish behavior—optimal foraging theory—in a study on River Danube cyprinids. Later, at Bangor, I investigated the genetic effects of introducing anadromous sea trout into brown trout populations above a waterfall to determine whether sea trout migratory behavior would preclude hybridization. In fact, hybridization did occur.

Your PhD research was based in Africa?

I studied a clupeid introduced into a reservoir. This fish completely changed its life history: In Lake Tanganyika, it averages about 13 centimeters long and lives typically for 2 years. In the reservoir, it is about half as long and an annual species. We wanted to determine whether some genetic change during introduction caused this, but we found no genetic changes.

What are some more recent foci?

I've been involved in several projects, most notably investigating the infamous Nile perch introduction to Lake Victoria, species translocations of cichlids in Lake Malawi, and loss of genetic diversity in a marine fish population in New Zealand due to overfishing. I also worked on a snail introduced to the UK from New Zealand, which is an excellent model system for evolutionary change. In addition, I was working on the population structure of several marine fish and shellfish species.

What attracted you to SAFS?

I like being in a place with so many people working on numerous aspects of fish research—especially on salmon—and all the possibilities for collaboration.

What is your research agenda here?

I'll be applying molecular tools to ecological and evolutionary questions, in particular adaptation to new environments. I'll focus on species introductions, overfishing, and pollution as model systems that can provide insights in evolutionary processes. On the applied side, such information can be used for predicting the success of species introductions, incorporating conservation genetics considerations into fisheries management, and assessing the long-term genetic effects of pollution exposure. One exciting prospect at SAFS is that all this can be done in collaboration with faculty from different disciplines.

I hope to continue my research in hot and interesting places, such as Africa. And, with four faculty members now in the Marine Molecular Biotechnology Lab—Ginger Ambrust and Gabrielle Rocap of Oceanography and Kerry Naish and myself of SAFS—I think we can develop an excellent molecular ecology program.

Will your research apply to aquaculture?

I am really more interested in wild populations, but the effect of hatchery releases on wild populations can be a very interesting model for demonstrating the effects of immigration and hybridization.

You'll be teaching a new course.

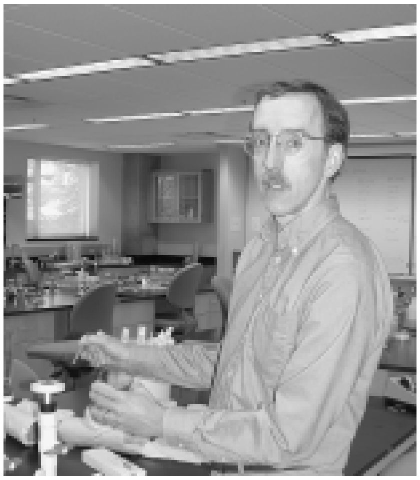
I was asked to design a 300-level course to introduce biologists to molecular markers and how to use them in ecological programs. I am very excited about this—I hope it will be a chance to get students interested before they get scared of genetics.

What contributions do you hope to make here?

Because I was initially trained as a fish and fisheries biologist, I have an understanding of fish ecology, life history, and fisheries, as well as the application of molecular markers. I think I'm well positioned to work with ecologists and develop projects using the latest molecular techniques. I look forward to using the range of skills and experience available at SAFS in conjunction with my own expertise.

I know you just arrived, but do you have any visions for the school's future?

I hope to continue my international research. I would like SAFS to strengthen its research ties with Europe, Africa, and South America. I also would like to see more foreign students at SAFS—international diversity can be very stimulating. ■



M. Duke

Russell Herwig

Research Associate Professor

PhD in Fisheries
University of Washington, 1989

Focus: ecological study of Bdellovibrio (a parasitic bacterium) in Puget Sound

Russell Herwig is on a mission to educate people about the microbial world. He put it simply: "Life on Earth would not exist without microbes. Because we can't see them, we tend to underrate their importance."

Russ became hooked on microbiology in graduate school. He accepted a post-doc at UW Microbiology, where he pursued research in microbial ecology, from whales to pollution to marine bioremediation. He returned to SAFS in 1985 to teach microbiology as it related to food science. He observed that "now is an extremely exciting time to be a microbiologist," especially with the molecular capabilities we now have and the SAFS/Oceanography Marine Molecular Biotechnology Laboratory.

Why are microbes so important in aquatic sciences?
The obvious answer for humans applies to seafood safety and public health. But microbes play a crucial role in supporting aquatic life. At the bottom of the aquatic food chain, photosynthetic microbes fix carbon dioxide into biomass. The energy and biomass that begins with microbes moves up the food chain and through life-history stages of many animals. At the other end of the spectrum, microbes are important in recycling: for example, decomposing crab shells and degrading the oil spilled by the *Exxon Valdez*.

What about bioremediation: does it work?
We investigated contaminated marine sediments in Eagle Harbor, Puget Sound, a ferry terminal site where creosote had been released into the harbor. The EPA isolated the contaminated subtidal sediment by capping it with clean sediment. But the cap tended to be scoured by passing ferries, and even where the cap held, the creosote could still leach onto surface sediments. So, there's no easy solution.

You are undertaking three major studies, one of which focuses on oyster larvae disease.
Graduate student Robyn Estes is studying a problem in shellfish disease, particularly oyster larvae. This is a basic, taxonomic investigation, which involves sequencing a particular gene—16S rRNA—to identify and characterize new organisms. 16S rRNA is ubiquitous throughout life, so it is used to determine how organisms are interrelated. The lack of good microbial fossil records makes evolutionary reconstruction difficult. The 16S rRNA can be viewed as an internal cell chronometer, and by sequencing we can reflect how this gene evolves over time. Add some mathematical calculations and a computer, and we can infer the microbe's phylogeny or evolution over millions of years.

This gene has revolutionized our understanding of the tree of life, helping prove there are three major branches of life—Archaea, including microbes that produce methane; Bacteria, from *Vibrio* to *E. coli;* and Eukarya, which include paramecium, metazoans, trees, you and even me!

You're studying a new way to process seafood.
This involves very high-pressure treatment with water. This technology, developed by a local company, may revolutionize the food industry almost as much as canning. We know this technology can kill bacteria in food—which extends shelf life. Faye Dong, graduate student Cindy Marshall, and I decided to look at whether high pressure could work on enteric viruses and parasitic worms.

And then there's the ballast water.
This involves co-investigator Jeff Cordell (SAFS fisheries biologist), graduate student Jake Perrins, and undergraduate student Ben Paulson. Ship ballast water is a major vector of exotic species introductions—an enormous problem. The "poster child" for this has been the zebra mussel, introduced into the Great Lakes with huge economic consequences because it clogs intake cooling pipes for facilities like power plants.

We are investigating three methods to eradicate or inactivate organisms in ballast water: ballast water exchange, ozonation, and ultraviolet light. There are pros and cons for these approaches, but there is tremendous interest worldwide to do something. How this is implemented and legislated I leave to other groups, but there is still plenty of science to do. ■

Robyn Estes

MS Student, SAFS

Focus: bacterial disease in oyster larvae

Supported by Washington Sea Grant Program and the SAFS Egtvedt Fellowship

M. Duke

Robyn, who comes from Spokane, earned her BS at SAFS, where she met faculty member Russ Herwig. After graduating, she worked with Russ as a technician and then, in summer 2000, enrolled in the SAFS graduate program.

How did you get involved with Russ?
Russ was assigned as my undergraduate faculty mentor because I had already taken a microbiology course. Then he asked me to help make media for a project to determine levels of *Vibrio parahaemolyticus* in adult oysters from Puget Sound. We used molecular methods–polymerase chain reaction–to look for genes that encode for *V. parahaemolyticus* and determine whether the form was pathogenic.

Your MS research also is focused on oysters.
I'm looking at bacterial isolates from bivalve larvae in commercial shellfish hatcheries in Hawaii and the Pacific Northwest. I'm investigating Pacific oyster larvae to help determine why we lose batches of larvae to disease. It's a potentially big problem, with economic losses for oyster growers around the world.

We know the cause is bacterial, but we don't know which bacteria. Bacteria occur naturally in the environment, but the hatchery seems to exacerbate the problem. So far, we can't make any correlation between bacterial outbreaks and other factors like pollution. We're trying to determine which bacteria are the most pathogenic. One hatchery has had problems for over two years and we've isolated the bacteria from that site.

We would like to develop a molecular method to detect the bacteria in the early phase of onset. This would be very helpful for hatchery managers: The sooner they could detect the bacteria, the sooner they could terminate a batch and stop wasting any more money on it.

What are your methods?
We have isolated about 118 bacteria from various hatchery locations and from the bivalves themselves. We're trying to determine the similarity among the isolates and identify species. I'm using fatty acid analysis and molecular methods to analyze them for similarity.

Are there any correlations based on location?
The bacteria occur in Hawaii and here, but we don't know the point of origin. The bacteria are very closely related between sites and between different bivalve species. The microorganisms in the hatcheries are also in the oysters. Because we can't sterilize the larvae, the bacteria are possibly being circulated between the sites.

How do the bacteria affect the larvae?
We're not exactly sure, but it kills larvae quickly. We note that a large proportion of the bacteria are *Vibrio* spp. In one experiment, I filtered the bacteria out of a culture and then put larvae in the remaining "broth," and eventually the larvae stopped swimming and sank to the bottom. Also, the larvae soft tissue was degraded. Possibly, some pathogenic strains are producing a toxin.

What are your plans after you graduate?
I'm talking with SAFS faculty member Carolyn Friedman about working with her because she specializes in shellfish diseases. I'm interested in working with aquaculture-related issues. ■

Why does seafood have such a short shelf life?

Dr. Microbe (aka Russ Herwig) says, "If you refrigerate something from a mammal, that's a much more radical shift in temperature, and the normal microbial activity is slowed way down. Microbes associated with a cold-water fish would not experience a radical temperature shift moving from the ocean to your refrigerator."

Photo top of page:
Listeria ©Dennis Kunkel
denniskunkel.com

M. Duke

Jake Perrins

MS Student, SAFS

Focus: ballast water treatment for the reduction of nonindigenous species

Supported by National Sea Grant Program, US Fish & Wildlife, and British Petroleum

Jake Perrins hails from Arizona. He earned his BS in Environmental Science at Northern Arizona University, focusing on microbiology. He came to the Pacific Northwest as an environmental chemist but had previously been interested in Russ Herwig's research program.

Jake completed the UW Extension Program in Wetland Management, then joined Russ' ballast water research program, a multi-year, multi-investigator collaboration of vital concern to the shipping industry and regulatory agencies. He will be continuing his ballast water research as a graduate student.

What's the latest in ballast water research?
Several projects seek to minimize exotic species introductions via ballast water in ships. Currently, the only option is mid-oceanic "exchange": Before a ship can release ballast water, it must exchange the ballast water from its point of origin with oceanic water at least 50 miles offshore. Exchange is time-consuming and costly, especially if a ship must divert hundreds of miles from a nearshore course. Our project involves sampling ballast water from ships in Puget Sound and developing assay protocols for monitoring ballast water exchange.

You're studying a potentially better solution.
We have a large project involving the installation of an ozonation treatment system on a commercial oil tanker, the S/T *Tonsina*. An ozone generator pumps ozone through a series of pipes into a ballast tank. The S/T *Tonsina* goes into dry dock this summer, and we will add more sampling lines to gain more information about water in the tank.

What does a typical day of field work entail?
Organizing a crew of about 15 and all the equipment is challenging. Testing takes 10 hours; setup and breakdown typically take several hours each. We were onboard from 7 am until 8–9 pm. Onboard, we sampled the ballast water prior to ozonation, and every 2.5 hours in two locations during ozonation as well as in a control tank. We sampled pH and dissolved oxygen, ozone, and total residual oxygen, which need to be done quickly. The rest of the work was done in labs.

What kind of results did you get in the lab?
Samples we took after 7.5 hours of ozonation had no culturable bacteria. We had a 10-liter carboy of treated ballast water from the last hour of onboard testing, which was kept at 10°C; after 7 and 35 days, there was no regrowth of bacteria. These results and others point to the question of latent toxicity remaining in the treated ballast water.

Results for microbial populations have been good, but not for zooplankton.
Zooplankton are larger organisms and it may take a longer period of exposure to see results. Ozone has a half-life of 5 seconds, but in a marine setting it creates residuals like hypobromous acid/hypobromite ion, which are highly toxic.

We need to account for the bromines before releasing ballast water into receiving waters. The question is, "Will we need secondary treatment, such as dechlorination using sodium sulfite?"

Now you want to test this underway.
The next phase will focus on latent toxicity where we will have a 5-hour exposure of ozone while the ship is at port, and then stay on board as it heads to its next port of call, sampling the treatment tank every 6 hours or so.

What are your long-term goals?
I would like to continue working on environmental projects that have broad real-world applications. ■

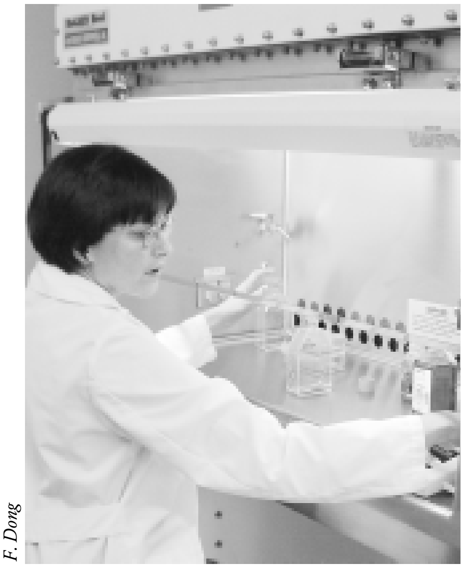
Cindy Marshall

MS Student, SAFS

Focus: shellfish virus eradication using high hydrostatic-pressure treatment

Supported by Washington Sea Grant Program, with matching support with equipment and technical assistance from Avure Technologies

Cindy Marshall was born in the Midwest, but has lived here most of her life. She has a diverse background: Technical degrees in drafting/design and water/wastewater treatment systems led to a job with an engineering firm that designed treatment facilities throughout the Northwest. She also has a BS in Environmental Health (UW). She taught community college courses required for licensing water/wastewater treatment facility operators. And she's worked as a food inspector. She credits the engineering work and the teaching for motivating her interest in aquatic-related health issues.


F. Dong

Did you aspire to your current research interests as a child?
[she laughs] You don't say, "I'm going to grow up and treat wastewater!" A high-school drafting course led to the engineering firm job. When I became interested in health aspects, I enrolled in UW Environmental Health, first as an undergraduate, then as a graduate student. I was studying antibiotic resistance patterns of fecal coliform in animals obtained from water samples.

What prompted you to transfer to SAFS?
I took several of Russ' microbiology classes. He wanted to study human enteric viruses in oysters and this piqued my interest.

Which brings us to your shellfish virus work.
This is based on wastewater treatment regulations and current developments in the National Shellfish Protection Program, which seeks ways to protect humans from diseases due to eating shellfish. The program looks at pre-harvest, harvest, and post-harvest operations.

We're interested in the Norwalk virus and hepatitis A, which often cause severe gastroenteritis after shellfish consumption. Episodes have been traced to infected harvesters on boats who dumped their sewage into water over oyster beds. A shellfish area can pass all water-quality testing standards and a virus may still be present. This is why post-harvest control is critical: it's the last resort for eliminating human pathogens.

You are investigating high hydrostatic-pressure (HHP) treatment.
I'm looking at how industry can better protect customers from viruses as shellfish are prepared for market. The food industry is using HHP vessels—subjecting foods to extreme water pressure—to destroy the bacteria or, in my focus, the viruses. We're talking about pressure that can cut steel.

In the food industry, most work has been on bacteria, with some success: treated food may not be completely bacteria-free, but consumers are less likely to get sick, depending upon individual immune systems. Work to inactivate enveloped viruses, which are similar to bacteria in their outer membranes, shows equal promise. However, hepatitis A and Norwalk viruses are different structurally and very resistant to treatment.

What other obstacles are there?
With vaccines, you can leave viruses in the HHP for 8–12 hours, and you can add chemicals. But the FDA prohibits chemicals in food processes, and an oyster subjected to 8 hours of pressure wouldn't be marketable. I've investigated each component of this treatment to determine feasibility. Will it work? Maybe; but for now, it appears only at extreme treatments that may not be marketable.

Besides food safety, this treatment has a "value-added" component.
The shellfish industry is using HHP to shuck oysters. At the same time, they're decreasing bacteria levels, which prolongs shelf life. The oyster stays intact, has the same raw aesthetic properties, and is still in the shell. Russ's group is also looking at whether HHP can inactivate parasitic worms in fish, which would be good for raw fish markets.

What are your plans after graduating?
I would like to continue teaching in some capacity, possibly education in an area of public health. ■

ENDOWMENTS

continued from page 2

H. Mason Keeler Scholarship (*Mrs. H. Mason Keeler*)

Danelle Heatwole (*C. Simenstad, advisor*): I would like to express my gratitude for your contribution to my graduate education. The funding is allowing me to study wetland ecology and restoration. My research will provide information for predicting the outcome of restoration efforts.

Willy Eldridge (*K. Naish, advisor*): Thank you for your financial support. [It] allows me to expand my understanding of our salmon resource, and one day hopefully identify better ways to protect and recover salmon and other fish species. I am interested in genetics and the interface between science and politics. Your generosity has helped me achieve a lifetime aspiration. ▪

The *Aquatic & Fishery Sciences Newsletter* provides current information on teaching, research, and service. Comments are welcome.

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