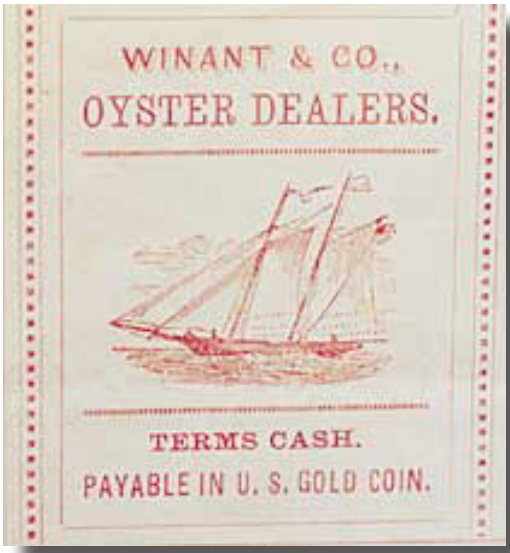
The Breed's in the Seed

Better oyster breeds are emerging from OSU's Molluscan Broodstock Program

by Ron Lovell



Oyster farming has a long history around Newport. In the 1860s Capt. J.J. Winant bought and sold oysters out of Oysterville near present day Newport. Photo: Lincoln County Historical Society

In 1853 Johan Gregor Mendel began a series of experiments that revolutionized plant and animal agriculture. The Austrian monk studied how offspring inherit traits from parents by cross-breeding flowers at his Augustinian monastery. His discoveries led to the development of controlled cross-breeding strategies.

Now, a marine scientist is using the same techniques to breed a better oyster.

"In many ways, oysters may be like corn or other cereal crops in that you have to cross specific lines or families to obtain the best hybrid offspring," says Chris Langdon. The OSU fisheries professor is heading a project called the Molluscan Broodstock Program at Oregon State University's Hatfield Marine Science Center (HMSC) to develop improved Pacific oysters.

"The cross-breeding strategy commonly used in agriculture has never been done with oysters before," Langdon says. "Our overall goal has been to develop the best breeding scheme for oysters," he continues. "Inbreeding helps purge the population of deleterious genes-those that can result in oyster death or slow performance. Our goal here is to genetically select oysters that are fast growing and disease resistant."

The Molluscan Broodstock Program (MBP) was started in 1995 as a special project funded by the United States Department of Agriculture. "There was a lot of support from the shellfish industry in setting up an oyster broodstock program at HMSC," says Langdon. "The East Coast oyster industry was in decline and growers were looking for a plan to develop a disease-resistant strain. Oregon was a good place to start because there is no serious disease in oysters here."

The Pacific oyster also has a long history on the West Coast. It was first brought here from Japan in 1918. "Industry knew from the start that this was the one to produce," Langdon says.

Unlike many agricultural industries in the United States, the West Coast oyster industry has never had a coordinated, long-term breeding program to improve commercial production. In effect, according to Langdon, the industry is still based on the culture of wild animals, without the economic benefits associated with domestication.

The MBP is designed to help the West Coast oyster industry implement a long-term broodstock selection program to improve future production. During the last five

Julio Correo-Ruiz harvests oysters grown on a suspended line in the Yaquina River at Oregon Oyster Farms. The facility provides space for MBP broodstock. Photo: Lynn Ketchum

Benoit Eudeline, research director at Whiskey Creek Shellfish hatchery, Netarts, puts larvae into 8,000-gallon growing tanks. Photo: Lynn Ketchum

years, technicians have produced and planted about 500 families of Pacific oysters at industry grow-out sites along thousands of miles of coastline stretching from Prince William Sound, Alaska to Tomales Bay, Calif. "We deliberately chose a wide range of sites to test the effects of different environments on genetic expression of oysters," says Langdon.

Commercial production begins when broodstock from HMSC is sent to the Whiskey Creek Shellfish Hatchery in Netarts, Ore., the only larval hatchery in the state. It is part of Taylor Shellfish Farms of Shelton, Wash. Here broodstock oysters are spawned and the resulting larvae reared for two weeks on a diet of algae in tanks of various sizes before they are shipped to oyster farms.

"Genetically, when you cross two oysters, you don't know what will happen," says Benoit Eudeline, research director at Whiskey Creek. "Oysters from some combinations grow faster than others. You want to pick the ones that grow best. Chris [Langdon] may tell us to cross #54 with #46 to obtain improved growth. We do that and see what happens."

Adds Sue Cudd, hatchery manager: "There is a lot less control than if we were raising chickens where you feed them and hold them while they grow. Oysters are fed by nature. It is a mix between farming and nature. It still depends on what nature gives us."

After a seven-day first step, larvae are collected in large tanks by sieving them on screens that look like big tambourines. The varying sizes of mesh allows technicians to accomplish certain tasks; for example, eliminating non-growing larvae by letting them pass through the screens leaving the usable larvae behind. After 10 days, larval densities are reduced to avoid over-crowding in the last stage of growth. The concentration of algae is increased each week to heighten the amount of food given to the larvae.

At the end of two weeks, larvae are measured out into volumetric plastic cones and sold in quantities counted in the millions. A typical shipment contains tens of millions of larvae and looks like wet sand formed into baseball-sized clumps and wrapped in moist white cloth. Then the clumps are placed in Styrofoam boxes and shipped to oyster farms via express mail. The hatchery processes 80 million larvae per day and has up to one billion larvae growing there at any one time, ac-

Xin Liu, (left) manager of Oregon Oyster Farms, Newport, and Chris Langdon, OSU fisheries scientist. Oregon Oyster Farms is cooperating in the Molluscan Broodstock Program. Photo: Lynn Ketchum

Eudeline looks through a screen covered with oyster larvae. Photo: Lynn Ketchum

cording to Eudeline.

One facility receiving larvae from MBP broodstock is Oregon Oyster Farms, located three miles up the Yaquina River from HMSC. Here in 500 acres of water leased from the State of Oregon, the larvae are "set" and the baby oysters, or spat, are hung out to grow in lantern nets suspended from rafts, 30,000 oysters per raft, for about 14 months. Oysters are also grown in mesh bags placed on the bottom of the river.

"We provide space to Chris for his oyster project," says Xin Liu, general manager of the farm. "We'll give him whatever he needs to finish his project. We are waiting for his results to see if we can borrow them. We prefer fast growing oysters. He is trying to select broodstock to develop the best oyster."

Liu came to OSU from China in 1992 and worked on his Ph.D. at HMSC before going to work at Oregon Oyster Farms. That facility produces oysters and sells its products widely in the state.

Harvesting oysters at the farm typically takes 14 months to 36 months, according to Liu. "Our hope is to improve our efficiency in terms of production," he says. "If the results are promising, maybe we will get to a 12-month growing cycle. A new idea always takes time."

Once the oysters reach market size, families producing the highest meat yields are identified and used to produce subsequent generations. To that end, Bill Dewey, an oyster grower and MBP executive committee member, surveyed 16 oyster-growing companies to determine which traits are most valuable to the industry. The findings in this survey guided the research effort, indicating that meat yield is the most important trait for the shellfish industry. Other factors were fast growth, long shelf life, a deeply cupped shell shape, and resistance to summer mortality.

Initially, broodstock was collected from wild oyster populations in Willapa Bay and Dabob Bay in Washington and Pipestem Inlet in British Columbia, Canada. Five founder cohorts-a cohort consists of a group of about 50 families-were produced from wild broodstock. "We then selected the fastest growing oysters from the founder cohorts and used them as broodstock to produce subsequent generations," Langdon says.

Before the hatchery and the farms come into play, however, an important part of the basic research takes place on the OSU campus where Mike Blouin, assistant professor of zoology and a co-principal investigator on MBP, is respon-

Closeup view of 18-day old oyster larvae at Whiskey Creek Hatchery. Photo: Lynn Ketchum

Dave Jacobson, manager of the Molluscan Broodstock Program at HMSC, inspects four to six month old "spat" or oyster seed. Photo: Lynn Ketchum

sible for checking the pedigrees of the oyster broodstock.

Because accurate pedigrees are essential for this project, it is important that scientists know the identity of all individual broodstock chosen for each generation. The repetitive, labor-intensive manipulations required during larval culture increase the chance that some cultures will become contaminated with individual larvae from other families. Such contamination can lead to misleading results in determining the response to selection and increased risk of inbreeding.

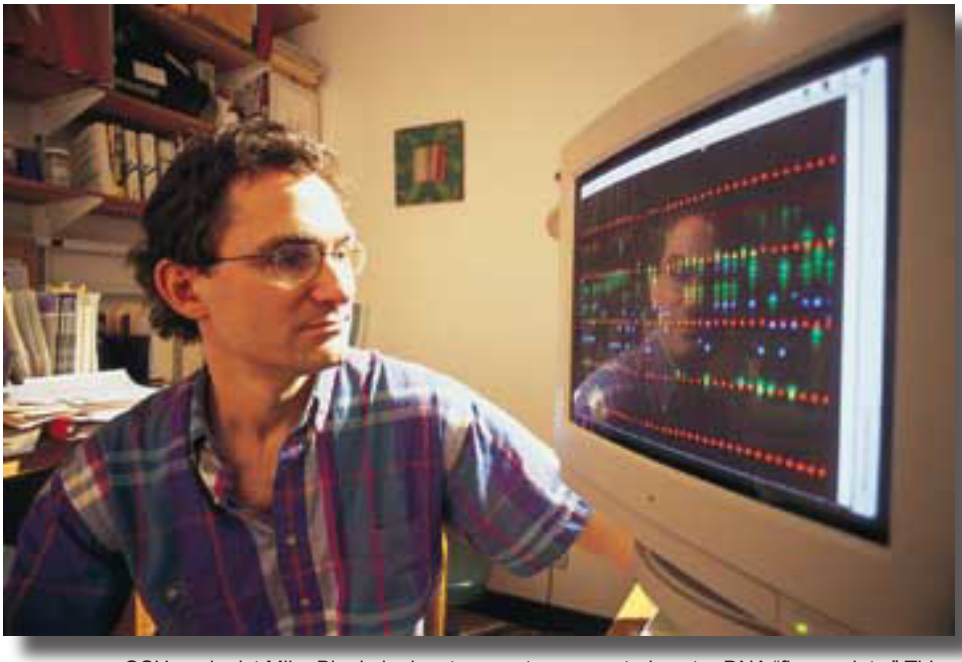
To avoid this problem, Blouin uses microsatellite DNA fingerprinting methods to verify the pedigree of each individual selected as broodstock in each generation.

Based on preliminary results, the selection program seems to be working. Offspring from selected top-performing families are on average significantly heavier than offspring from wild, non-selected broodstock. Furthermore, the top five families from selected broodstock are about 25 percent heavier than offspring from industry's own supply.

More information on MBP results can be found at the MBP website at http://hmsc.orst.edu/Projects/mbp/index.html. It provides information on the research progress, personnel and long-term plans for the program.

In their work, the scientists take care to assure that neither diseases nor unwanted organisms are accidentally transferred with oysters transported between the Marine Science Center and industry sites. Oysters originating outside Yaquina Bay, for example, are disinfected upon arrival and handled under quarantined conditions until ready for spawning. Offspring are raised from the larval to the juvenile stage under conditions in which all incoming seawater from Yaquina Bay is sterilized by filtration or UV irradiation.

Oregon has become a nucleus for oyster research on the West Coast even though the industry is bigger in Washington-an annual production of $68 million last year vs. $1 million worth of product in Oregon, with lesser amounts in California, Alaska and British Columbia. Washington also has the best growing areas in Willapa Bay, Grays Harbor and Puget Sound. Oregon's dominance in research stems from the long tradition of more than 30 years of cooperative research work with the oyster industry. The University of Washington has no marine research facility. Oregon also has a very active Coastal Oregon Marine Experiment Station (see Oregon's Agricultural Progress, Spring 1999), under whose auspices this work is being carried out.



OSU zoologist Mike Blouin looks at computer-generated oyster DNA "fingerprints." This allows researchers to doublecheck oyster pedigrees and prevent culture contamination. Photo: Lynn Ketchum

Noberto Hernandez sorts adult oysters at Oregon Oyster Farms on the Yaquina River. Photo: Lynn Ketchum

Langdon has high hopes for expansion of the shellfish industry on the West Coast, but such prospects are not without problems. "Total area of water available to produce oysters is reduced year by year by the pressure of coastal development," he says. "A high proportion of the population lives on the coast where folks want to build homes, shopping malls and marinas.

"All this development generates waste from septic tanks, sewage systems and runoff from parking lots and roads," says Langdon. "The oyster has to continually fight for its existence, even though the industry has been farming coastal waters for about 100 years-long before water skiing and marinas became popular. The oyster industry's fight for clean water has benefited all coastal inhabitants but it has been a lonely fight at times."

One of the best oyster growing areas in the state used to be Tillamook Bay, but it is not as productive for oyster culture now because of the runoff from local dairy farms, sedimentation and expansive beds of burrowing shrimp that soften the sediment and smother the oysters. Ghost and mud shrimp have no commercial value.

"It is very difficult to control burrowing shrimp without the use of pesticides, something that is taboo in Oregon," says Langdon. "Washington, on the other hand, does allow some spraying to control these creatures there."

There are other drawbacks. Harvesting time is considerable. Fourteen people must spend a week just removing barnacles from individual oysters by scraping them off. "It is an expensive, labor intensive work," Langdon says.

Langdon hopes that progress in MBP will attract additional long-term support for shellfish research. "The great advances in land-based agriculture over the last century have been partly due to long-term federal research support," he says. "Unfortunately, most federal agencies, apart from the U.S. Department of Agriculture, do not fund aquaculture projects on a long-term basis, resulting in frustratingly slow progress. It would be hard to carry out selective breeding of oysters with only a couple of years of funding."

Because all research programs have finite life spans, Langdon is preparing for the day when funding for MBP runs out. "We are beginning to work on the best way for industry to support MBP in the future," he says. "There are several strategies: 1) form a cooperative for oyster broodstock improvement at the Hatfield Marine Science Center supported by industry, or 2) have the industry take over the breeding program and set it up in a commercial hatchery. The latter approach has been successfully adopted by the Norwegian salmon industry."

Looking to the future, Langdon sees potential for market growth overseas. "There are good business possibilities for the shellfish industry if we can develop genetically superior seed for foreign sales," he says. "The Pacific oyster is truly a global species. It is cultured now in Australia, New Zealand, Europe, many parts of Asia such as Korea and China, and in North and South America."

But, he cautions, France, Australia and New Zealand are already setting up programs modeled on the MBP. "These programs are very well funded but we still have a significant lead," says Langdon.

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