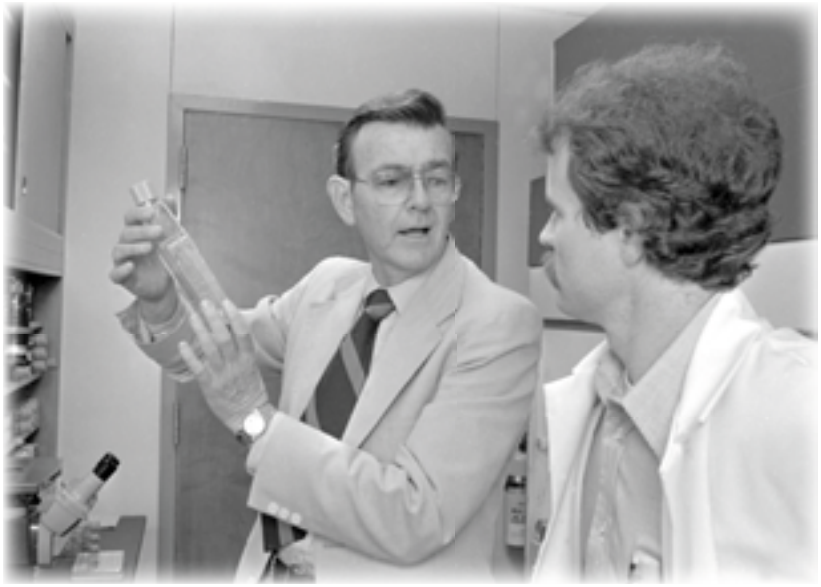
Grooming a new generation of scientists

For many scientists, mentoring a young researcher from student to full-fledged colleague is second only to the satisfaction of scientific discovery itself.

John Fryer, a pioneer in fish microbiology at Oregon State University from the 1960s until his retirement in the late 1990s, had the privilege of doing just that. And along the way, one of his protégés, with the support of Oregon Sea Grant, helped unravel a mystery that had plagued fish biologists for decades.



John Fryer mentored hundreds of graduate students over his 37-year tenure at OSU. He is shown here with a student in his lab in 1980.

For more than 30 years, scientists and wildlife managers had been puzzling over the failure of a grand plan to farm coastal steelhead and trout and release them into Oregon's Willamette River system, which had been depleted of fish by a century of overfishing. Between 1966 and 1975, the project released more than 1 million smolts into the rivers. But none of those fish ever returned to the river as adults.

In retrospect, scientists now agree that the fish probably were killed by *Ceratomyxa shasta*, a tiny parasite related to the organism that causes "whirling disease," a lethal condition that has devastated salmon and trout populations in the Rocky Mountains.

First identified in 1948 at a hatchery near Mt. Shasta, California, *C. shasta* has probably always existed in some of the Northwest's inland watersheds. Fish that live in those rivers have evolved enough resistance that they often survive infection. But coastal rivers are free of the parasite, and so fish born and bred there have developed no resistance to it. Transported to infested waters, those fish quickly die.

Fryer's team at the OSU Fish Disease Lab, along with scientists from state and federal wildlife agencies, had been studying *C. shasta* since it was first found in Oregon in the 1960s. They could see it in the intestines of infected fish, and they learned that it was released from the fish as a spore. But what happened to the spore after it left the fish was a mystery. And there were other questions: One infected fish cannot infect another. Why? Why did the organism fail to spread from drainage to drainage as other diseases do? Why was it found in some rivers, or stretches of river, but not others? And what allows some fish stocks to resist the parasite, while others succumb?

Jerri Bartholomew, meanwhile, was growing up and getting an education. In 1981, as a young master's degree candidate, she joined Fryer's lab as a graduate research assistant and quickly became interested in the *C. shasta* mystery.

By then, researchers elsewhere had learned that a related parasite that causes whirling disease goes through several life stages. Besides the stage that infects fish, scientists discovered, that parasite spends part of its life in a completely different

physical form, during which it infests a certain type of aquatic worm.

Fryer thought C. *shasta* might have a similar life history. Working under funding from Oregon Sea Grant, the U.S. Fish and Wildlife Service, the Bonneville Power Administration, and other agencies, his team began dredging up debris from the bottom of infested rivers—rocks, muck, freshwater mussels—and putting it in laboratory tanks containing uninfected fish. Sure enough, those fish became infected with C. *shasta*.

"We knew the infectious stage of the parasite was present," Bartholomew recalled later, "but we didn't know what it looked like or what its host was."

Then, in one of their tanks, Bartholomew and her colleagues discovered a tiny worm infected with spores that looked very familiar. They began to gather the spores released by the worm and feeding them to fish in the lab. For three months they waited anxiously, checking daily to see if the fish were still alive. Finally, over Christmas break, Bartholomew discovered that the fish had died and that their guts were teeming with C. *shasta* spores.

"I never thought I could be excited by a fish dying," Bartholomew recalled. "After 16 years of looking for the alternate host of C. *shasta*, I was really thrilled. We celebrated over champagne."

Using high-tech molecular analysis of the organism's DNA, the OSU team was able to confirm that the spore found in the aquatic worm was, indeed, a life stage of the same organism that infests and kills fish.

The discovery taught biologists an important lesson about the potential failings of hatchery production and the need to preserve native fish stocks that have built-in resistance to the pathogens that might be found in different streams. Bartholomew's work with DNA probes, meanwhile, has provided biologists with an important new tool for learning about other organisms that cause disease in fish. The U.S. Fish and Wildlife Service is adapting her methods for a national survey of the health of wild salmon and trout stocks.

Such long-term efforts depend on long-term funding, and Fryer credited Sea Grant with supporting his team over the years: "I'd rather have a modest level of annual support than have someone throw $1 million in my lap and say, 'You've got to spend it now.'"

While working on the C. *shasta* puzzle, the former graduate research assistant earned her master's and doctoral degrees, and is now Dr. Jerri Bartholomew, an assistant professor in the OSU Department of Microbiology and senior researcher in the same lab where she helped solve the C. *shasta* mystery. Fryer, meanwhile, worked right through his 1997 "retirement" and continued to advise the OSU Fish Disease Lab as a distinguished emeritus professor until his death in 2004 at age 75.

Fryer considered Bartholomew a classic example of the payoffs that can come from the teacher-student relationship. Over the decades, he mentored dozens of students who went on to become serious, contributing research scientists. Today, many of them head their own research facilities around the world.

In the late 1990s, Fryer recalled attending an international meeting of fish biologists a few years earlier. "Someone asked everyone who had ever visited our lab to stand, and then everyone who had ever stayed on to do some work, and then everyone who had earned a degree while working here. By the end, virtually everybody in the hall was standing up. It was a moving moment for me."

And he was especially proud that it was one of those students who solved the *Ceratomyxa shasta* mystery. "We've worked on that thing since the late 1950s," he said. "If somebody else had broken that life history, I don't think I'd ever have recovered. I wanted it so bad."

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