

Life Cycle of a Lab

Research on the Klamath River

Written and photographed
by Jeffrey Basinger





*In the Klamath River, five hours southeast of their lab at Oregon State University, Julie Alexander and Luciano Chiaramonte collect polychaetes, which are part of the *C. shasta* life cycle.*

Julie Alexander and Luciano Chiaramonte fight currents and grip submerged boulders under the turbid waters of southern Oregon's upper Klamath River. They swim separately but within sight of one another. Alexander wears a thick wetsuit, but "Luc," as Alexander calls Chiaramonte, sports only trunks, despite the cool air shaded by clouds. Even in summer, at this elevation it is cold.

Snorkels extend from the researchers' mouths as they bob upstream between rocks and reeds. Behind her mask, Alexander's eyes scan the underwater landscape as she moves.

Chiaramonte and Alexander, a post-doctoral scholar and a master's student, respectively, are working at the bottom of a steeply sloping valley flanked by tall alder trees. One side rises to a long

cement wall, which splits the river a few miles behind them, sending most of the flow along a higher elevation, toward one of the many power-generating dams in the Klamath basin. Not long ago the area was well used by a fishing community, and shortly before that, it was sparsely inhabited by Native American tribes.

No longer. The native communities have dwindled, and the fishing industry along the Klamath River was shut down after salmon populations decreased to unsustainable levels. Where once ran the third-largest salmon population in the world, the Oregon Fish and Wildlife Department now estimates the population at 1/16th its former size.

Essayist Elizabeth Woody wrote that the number of salmon in the Northwest had once been so plentiful that their splashing during upstream migration

would spook horses. The fish now move much more quietly. Klamath River levels rise to a fraction of their historic height. Like low blood pressure, the veins of the landscape pulse slower, with dizzying effects on adjacent communities that rely on jobs and food from these ancient waterways.

The Klamath River is notoriously odd. "Normal" rivers begin clean and clear at their start and then flow downstream, picking up sedimentation from river development or pollution from city corridors, becoming progressively dirtier. By contrast, the upper stretches of the Klamath are murkier than the lower, due to numerous dams and old log-transport practices that scraped and deformed the upper river's beds, while the lower stretches are fed sporadically by cold, clean tributaries.

To be fair, however, the system may have always been a bit backwards; upper Klamath Lake has always been a eutrophic (or nutrient-rich) “head-water.” Because of this, the National Geographic Society refers to the whole system as “upside-down.”

Dams, pollution, and environmental degradation have been factors affecting salmon in this area, but another factor has the attention of Oregon State University scientists.

Chiaramonte and Alexander swim in the shallow water, occasionally diving beneath oblong rocks, peering under ledges, and feeling with their fingertips. Alexander spots what she’s been looking for, digs in her heels, and rises from the ripples. Because the rushes of water drown out audible communication across the river, Alexander signals to her colleague with a large waving gesture. Then, with a downward motion of her hand, she disappears again.

Chiaramonte understands: Alexander has found a mass of polychaete communities, which the team will collect for experiments back at the lab. The little creatures, which look like mounds of tiny macaroni sponges, number in the tens of thousands here. At the tip of each critter white hydra heads protrude, catching microscopic particles that flow into their grasp.

Chiaramonte lets the current take him toward Alexander. He dips a homemade PVC net into the water while Alexander scrapes a chunk off the rock surface into the container. The little polychaete communities drop through the water like leaves in autumn, swaying slightly before coming to rest in the container’s bottom.

Essentially, Chiaramonte and Alexander have come here to collect small worms, for tests back at the lab. As strange as an upside-down river may seem, the worms may hold a key to protecting the salmon.

The pair pack up their gear, swing by another site to collect water samples for a colleague, and then drive five hours back to the lab while talking about hunting trips and upcoming barbecues.

Their research revolves around the life of the microscopic, freshwater parasite *Ceratomyxa shasta*, a prime suspect in the decline of Klamath River salmon. Back at the lab, wearing a lab coat rather than a wetsuit, post-doc researcher Stephen Atkinson works to decode *C. Shasta’s* genome, and the process looks complicated. After being collected from the intestine of an infected fish, the spores of the parasite are lysed, or cracked open. The DNA is caught in a filter device that allows all other biological material to escape. The DNA is taken through a series of incubations, mixed with clear liquids in tubes labeled with various numbers and letters, occasionally twirled in a device that resembles a salad spinner, and finally sent in vials to another lab for sequencing.

The data comes back from the lab via e-mail; attached to the e-mail is an assembled skeleton of a genome, a roadmap that will help identify differences between specimens. This will be the first DNA sequencing of its kind, as no

other animal in this phylum has had its genome decoded.

Alexander, Chiaramonte, and Atkinson work for Dr. Jerri Bartholomew, a fish pathology professor at Oregon State University and director of the John L. Fryer Salmon Disease Laboratory. Academically, Bartholomew is known for her discovery of *Ceratomyxa shasta’s* life cycle. She has received funding for her fish disease research from Oregon Sea Grant (and many others) since the 1980s.

Like the “chicken or egg” riddle, this mystery begins with either a worm or a fish, one of two hosts to the *C. shasta* myxozoan parasite. Within the small, aquatic worm, the parasite develops and eventually releases in expelled mucus. In the water it floats aimlessly until juvenile salmon or other fish inadvertently filter it through their gills.

Here is where the *C. shasta* parasite attaches, at this point resembling a small, clamping Pac-Man (actinospores). It replicates and soon migrates into the gut, where it destroys intestines and creates kidney pustules—often fatal to juvenile salmon. Spores (myxospores) released from the decimated fish flow through the water and eventually into the worm’s filter feeders, where they settle again, completing the cycle.



Attached to a submerged boulder, a community of tiny polychaete worms extend hydra-like heads from beige tubes.

The parasite bounces back and forth between its hosts, often taking out juvenile salmon along the way—in some areas increasing population mortality beyond the point of a sustainable fishing river. Bartholomew's research has revealed that in some areas of the Klamath River, more than 80 percent of juvenile salmon may become infected.

Attention turned to *C. shasta* after a dramatic fish-kill in 2002, when the U.S. Fish and Wildlife Service cited “a combination of factors” in the deaths of an estimated 34,000 fish. In 2004, scientists took note of the myxozoan parasite *Ceratomyxa shasta*, which had

infected the intestines of over 45 percent of juvenile fish captured that year.

Today, each member of Bartholomew's dynamic lab approaches the problem from a different but related angle. While Richard Holt, a retired fish pathologist, oversees the field work and provides his extensive knowledge on the history of *C. shasta* in the Northwest, Oregon Sea Grant-funded Ph.D. candidate Adam Ray concentrates on modeling—making projections on how climate changes in the basin will affect disease in fish by using the information gathered from Chiaramonte's work. Chiaramonte studies temperature, which is informed

by Alexander's polychaete work, as she explores the question of river geology and polychaete abundance. Alexander works closely with Michelle Jikaitis, who studies hydrological effects on the polychaetes, such as how adding gravel to the riverbed might help disrupt the polychaete population. Charlene Hurst concentrates on parasite competition, and Atkinson, who discovered that the parasite has multiple genotypes, is working on genome sequencing. None of them wants to eradicate either the worm or the parasite it houses; they're simply researching what options exist that can control the levels of each. Perhaps two



A pair of spawning Chinook salmon. Chinook are one of the salmonids affected by the parasite C. shasta.





Jerri Bartholomew advises graduate student Michelle Jikaitis, who studies disease risks and pathogen transmission between hatchery fish and naturally reared populations.

genotypes of the parasite in conjunction could nullify one another.

At a lab meeting, Chiaramonte stands at the head of a table, speaking to his colleagues. He explains his research on temperature in simple terms, relating it to climate change and describing the potential effects temperature could have on rates of parasite infection in juvenile salmon. He goes through this rehearsal at Bartholomew's request, as she has made it clear to her lab that communicating their science clearly to management and community members is essential.

Many science labs, while efficient and productive, are more individually focused; each student works on his or her own project, separate and secret from other lab members' work. In fact, some labs are internally competitive environ-

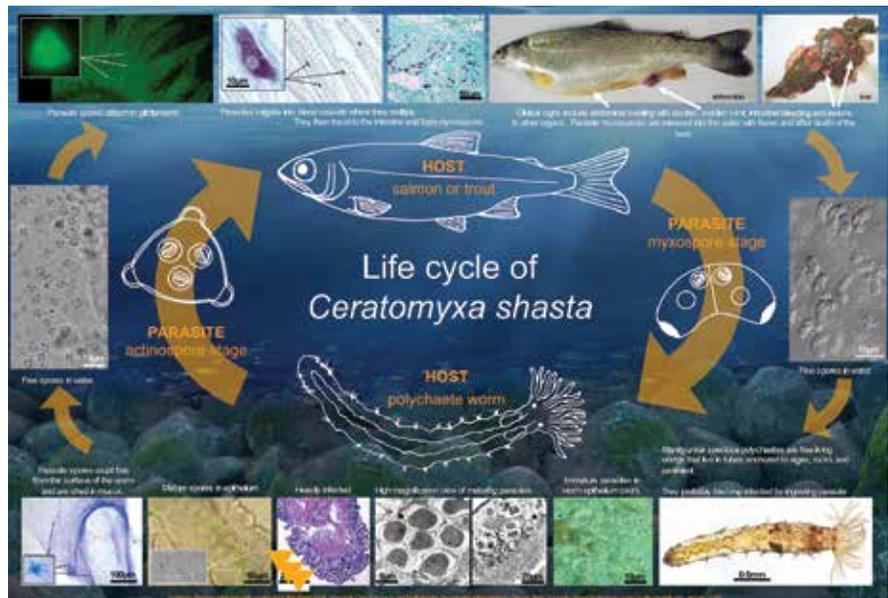
ments, where sabotage is not unheard of. But something feels unusual about the Bartholomew lab, and one might notice it while swimming in the Klamath with Alexander and Chiaramonte or sitting in the lab with Atkinson. It's also noticeable in Bartholomew's office, where her own handmade glass salmon sculptures rest on windowsills and her door remains open for pop-in questions while she works. The sensation is present even in a weekly lab meeting, where delicious brownies sit at the table's center and the first twenty minutes of the meeting are filled with talk of barbecues, accompanied by a slideshow from recent outings along the river. Meetings are occasionally held at local bars; Squirrel's Tavern is the team's hangout of choice. This lab, it seems, is something akin to a family.

The lab is uniquely cooperative, and according to multiple current and former lab members, this is entirely intentional: when Bartholomew sits in front of a stack of applications from potential students who wish to be part of the lab, she doesn't simply pick those who have the best credentials or grandest ambitions. She chooses people that she feels will "fit" with the group, who will work well as part of her team. She looks at the whole person—hobbies, interests, experience. And her students and ex-students alike attest to her skills at reading people. Bartholomew considers it essential for her lab partners to have interests besides science and work. She herself is an artist on the side, often creating fish-themed sculptures or paintings. On her reasons for promoting well-roundedness, she half-jokes, "It would be awkward to have

nothing to talk about on five-hour car rides to field locations.”

Bartholomew says she doesn't know for certain whether her methods of running a lab benefit the science; she admits that sometimes the chatter and friendly atmosphere can delay progress—or efficiency at meetings. But obvious benefits emerge, as each member of the team seems happy to be there—even when working on other members' projects: the polychaete collection on the Klamath was for Alexander's research, not Chiamonte's, despite his assistance. But he returned the favor for her previous help on his thesis. They're not just colleagues; they are friends. It's commonplace in the Bartholomew lab to share resources and assist each other's research. Many of the students in Bartholomew's lab will one day direct their own—and they'll likely emulate her style, completing the lab's life-cycle.

Bartholomew explains that the entire lab can function the way it does because they have a common goal: to use their research to inform management decisions. The Bartholomew lab has goals beyond “science for the sake of science.” That is, they aren't working toward simply collecting and interpreting data. Data is always a good thing, a necessary thing, but the ultimate aim of Bartholomew's research is to help Klamath River salmon populations and revive the river's fishing industry.



A poster of the *C. shasta* life cycle, created by Jerri Bartholomew and her team.

Scientist-artist Jerri Bartholomew recently completed a series of Portland bridges in glass, and her lab itself is a picture of bridges. She and her co-workers build a bridge between the gritty work done in the field and the research conducted in a lab. Bridges connect the hard science and research to the community, and to managers whom that research might help. A bridge crosses the divide between work and play. And through a common goal, each member of the team is connected; each research project gives weight and data to another.

“Ultimately we're trying to benefit the fishermen,” says Bartholomew. “We want to benefit those who make a living

off of fish. And we're trying to benefit us, those of us who consume fish, as well as the health of the fish themselves.” Should this animal's life-cycle be understood and managed effectively, perhaps not only could the lost fishing industry of the Klamath basin be restored, but other fish diseases that plague the Pacific Northwest and elsewhere might be minimized and controlled as well. While some of Bartholomew's team meets at Squirrel's to practice presentations, and others swim in turbid waters or decode DNA indoors, the Bartholomew lab may yet be the bridge that brings salmon and the fishing industry back to the Klamath River.



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