In marine scientist Hans Dam’s laboratory at UConn Avery Point live myriad tiny animals that skitter about in a safe and comfortable tank of seawater. While they’re almost impossible to see with the naked eye, these small, transparent creatures play a vital role in the aquatic food chain of Long Island Sound. They are known as copepods, and according to Dam they may be in trouble.

If this is the case, so are the rest of us. Climate change and warming temperatures in the temperate waters of Long Island Sound may threaten their survival, and with it, the sustainability of the valuable fisheries in the Sound that depend upon them to nurture their young.

That is the concern behind Dam’s research and a two-year project he has undertaken with funding from the Connecticut Sea Grant program. The project is looking at the ability of copepods to withstand rising water temperatures and occasional blistering heat waves. Dam said he developed this interest as an undergraduate at the University of Washington, where he acquired a passion for plankton, the microscopic plants and animals that are swept about by the tides and currents of the sea.

“Funny, people think that the ocean is dominated by large fish, but that’s only a small fraction of what lives in the ocean” said Dam in a recent interview. “Most of the life is tiny, some of them you can’t see, but they’re superabundant and they drive the biology of the ocean.” Dam noted that he likes fish, but they’re too difficult to work with. “Unlike fish, copepods lack complex behavioral patterns, making them just simple enough to make sense of,” he said. “They grow fast so you can keep them in the lab. If you try to experiment with fish it would take years; with copepods it takes weeks.”

Copepods may be small and simple, but they’re the foundation for the food web of the Sound, he said. They are a main source of food for the nurseries of all varieties of fish. They are, Dam’s former post-doc research assistant, Michael B. Finiguerra adds, the essential links in the food chain to higher marine organisms. “Much of the fish in the Sound consists of stripers, bluefish or flounder. When they’re larvae, they eat copepods.” says Finiguerra. “Any disruption to that relationship could affect that fishery, and if copepod populations drop with the spawning of blue fish, those larvae won’t have any food to eat.”

Finiguerra said that both he and Dam are analyzing the effects of weather extremes,
Hans Dam evaluates algal cultures used to maintain copepods in his lab at UConn Marine Sciences.
such as heat waves on copepods. Because copepods are cold blooded, they are susceptible to temperature changes, and when temperatures are near the maximum for copepod performance even the smallest change can affect the population to a serious extent. “Can copepods deal with a heat wave in their own generation?” asked Finiguerra, “and can this heat wave have an effect on future generations of copepods?”

Finiguerra noted that the copepods are “the link between the grass of the sea, the phytoplankton, and all the higher order organisms.” That is why marine scientists like Dam who study this Lilliputian marine world are worried about rising temperatures that have taken place in bodies of water like Long Island Sound as a result of climate change. This temperature increase has been a noticeable problem in the Sound since the 1940’s, with almost a 2 degree Celsius increase in the waters since that time, he said. That doesn’t sound like much, but it’s already had a perceptible impact on the copepods, according to Dam. With the warm water came two big consequences for plankton in the Sound, he said. With copepods there is an inverse relationship between size and temperature, with warmer waters there are smaller copepods. “That means the fish larvae that depend on the species for food are eating smaller organisms.”

Secondly, he said, the smaller species have also started to become more prevalent in the winter because the winters have become warmer. The cold-water copepods now have a competitor. “Fish are particular. They have preferences for what they eat,” said Dam. “You might see that the fish here in wintertime aren’t doing that well. We’re seeing that some of the fish are being replaced.” Through this latest project, the scientists want to know just how prevalent that is. “Are the species attuned to cold water going to suffer? And to what extent can these species deal with environmental changes to better suit themselves?” Dam said.

To do experiments, copepod samples from the Sound are collected and brought to the laboratory at the Avery Point campus. There they are bred and raised for a few generations under standard conditions, to remove any previous environmental and maternal effects. As Dam mentioned: “We treat them like royalty, raise them in the exact same conditions for three generations to remove their previous history.” Then, they expose copepods to simulated heat waves for different periods of time and measure their fitness, survivability and ability to reproduce. Because of the short lifespan of the copepod—just a few weeks—the scientists can test for the adaptation of the individuals in a few generations. Through the simulation, they were able to test what happens to the copepods if heat waves happen early or late in their season of growth.

“If there’s an early heat wave, can they cope with the change? What about those that survive and their descendants when they appear in the next year?” he said. Will the ones that survive a heat wave create descendants that won’t do as well in colder conditions next time around? The issue pits plasticity, the ability of the individual organism to acclimatize during their lifetime, against evolutionary adaptation (genetic changes across generations). Surprisingly, no one before has looked at the comparison of copepod plasticity vs. their evolutionary adaptation in response to heat waves.

The results of this research thus far may have important implications for fisheries, with the threat of climate change and increasingly warmer waters impacting the growth and food source for many fish larvae. “Their (copepods) growth and behavior will be dictated by the change in climate in each region, and their ability to adapt,” said Dam.

Since wrapping up their heat wave simulations both Dam and Finiguerra have focused their attention on ocean acidification occurring in the Sound as climate change increasingly adds carbon dioxide to the waters. “People often ignore copepods affected by acidification because they don’t have calcareous shells” said Finiguerra. “They think that copepods aren’t affected in a similar way to clams, oysters and other shelled organisms.”

The acidification of the water according to Dam “has metabolic consequences such as requiring the copepods to spend more energy maintaining their vital processes than to work on reproducing and growing larger.” Ocean acidification and temperature may be working together to stunt the overall population growth of these copepods.

For fisheries, warming and acidification bring serious conservation issues to the table. “Species can be extremely plastic,” said Dam. “But the question is: How wide is their temperature or pH1 envelope and will climate change push them out of it?” The lack of a sustainable food link between primary producers and consumers is likely to have a very tangible effect in the near future. “The kinds of fish out there may look entirely different. It might not be a fishery that’s sustainable for consumption.” Dam and Finiguerra both hope their work will better inform fisheries management and policymaking for Long Island Sound and other waters.

ABOUT THE AUTHOR:
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