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Research Note: Tammy De Ramos and Kevin Curry

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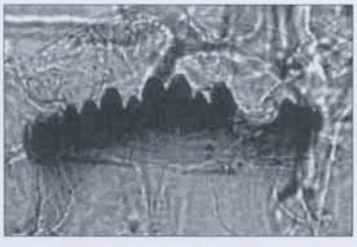
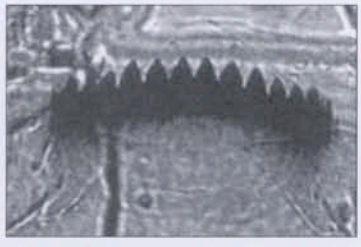
Heavy Metals in the Taunton River Tributaries: Research by Professors Tammy De Ramos (Department of Chemical Sciences) and Kevin Curry (Department of Biological Sciences)

Professor Tammy De Ramos of the Department of Chemical Sciences is studying water quality in the Taunton river and some of its tributaries. The story of the origin and conduct of this work provides an excellent illustration of the normal operation of the scientific enterprise and the way research can suit the needs of a college like Bridgewater and its community. It features a mix of curiosity, collaboration, teaching, discovery and civic need. It's also a story that begins in the jaws of a wee beast.

In the spring of 1998 Dr. Kevin Curry was conducting some sampling in local rivers with of his undergraduate students. His research group was focusing on a tiny insect called a chironomid that lives its larval stage in the sediments at the bottoms of rivers. They found high rates of physical deformities in the mouth parts of the insects, such as missing teeth and gaps between teeth. These deformities have been shown in other studies to be related to pollutants such as heavy metals, pesticides and polychlorinated biphenyls (PCBs). (The deformities Curry and his students found are shown in the series of pictures below.) Because the larval stage chironomids thrive in the sediments, they are exposed to the environments in both the water and the solids in the stream bottom. In addition the insects do not move any distance during the larval stage. Thus, they are good indicators of a range of pollutants and serve as reliable sampling units.

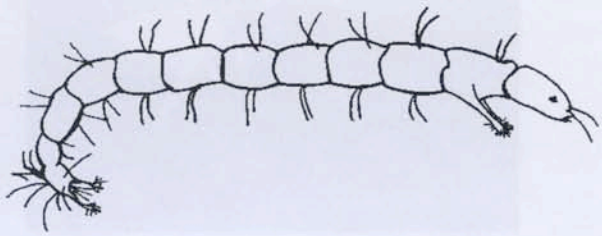




Pictured above left: deformed mouth and teeth of a chironomid. On the right are a normal chironomid mouth and teeth.

Suspicion of the presence of heavy metal pollutants in these waters was especially interesting to Curry since the College, using money Curry obtained in a 1998 grant, had recently purchased an instrument capable of measuring their levels. The instrument, called a graphite furnace atomic absorption spectrophotometer (GFAAS), is housed in the Chemistry Department and is used in research and in sophomore and senior-level instrumental analysis courses taught by Dr. De Ramos. Collaboration between Curry and De Ramos (and the involvement of chemistry students in the collection and measurement of samples) was a natural fit for the study of these pollutants. Recently their project received funding support from the Center for the Advancement of Research and Teaching.

According to Dr. De Ramos, heavy metals such as cadmium, copper, lead and zinc have specific gravities greater than that of water and all have been found to be related to chironomid deformities in other studies. In addition these metals are especially good research tools for the study of pollution since they are toxic at very low levels or concentrations. (Measurements sensitive to concentrations of only a few parts per billion are termed "trace" amounts.) To study the levels of pollutants in the water, samples are taken from area river sites within a one mile radius in the Taunton River tributary system. The first sites were chosen because they were suspected to be likely places where pollutants would be found. Samples taken from upstream and downstream of a sewage treatment facility (Town River) and a car junkyard (South Brook) provided the preliminary indications of the presence of chironomid deformities. Another site several miles away and not close to any obvious source of pollution was sampled to provide a baseline for comparison of levels of chironomid deformities. This site yielded results that puzzled the researchers since it showed levels of deformity comparable to the earlier samples. This raised the possibility of more generalized findings of pollution, a problem to be addressed in the research. In a follow up study, Dr. De Ramos' research group, comprised of undergraduate students, will begin sampling this spring after the water levels drop and continue sampling until October. Both water and sediment samples will be taken this time and treated to preserve them for analysis in the graphite furnace.



Measurement of the levels of heavy metals is accomplished by introducing very small, carefully controlled volumes of samples from the water and acid-dissolved sediment materials (typically 20 microliters, well less than a drop in each sample) into a miniature graphite tube called a furnace. The furnace is then set in a cradle in the spectrophotometer where it is electrically heated to temperatures between 1900 and 2500 degrees centigrade. The heat to be achieved is selected to match the level at which the specific metal being tested is known to vaporize. As the metals vaporize, they enter a shaft of light passed through the furnace and absorb some portion of the light. Comparison of the level of light entering the furnace with the level of light leaving it yields a measure of the level of metal in the small sample in the furnace. The greater the amount of metal in the sample, the more vaporized metal will be detected by the machine and indicated as a digital readout.

Top photo: Students sampling sediments from the Taunton River Watershed. Bottom photo: Testing samples in the graphite furnace.

Research like this requires the combination of a number of elements to be successful. First, there must be people who are aware of the environmental and research issues. In this case, Kevin Curry is experienced in issues of environmental quality, especially as they relate to fresh water systems. He has already conducted a number of studies of water quality in local rivers and ponds. Tammy De Ramos has a background in the field of analytical chemistry, with an emphasis on the use of spectroscopic techniques in chemical analysis. She has used and taught with the college's graphite furnace spectrophotometer for years and has received additional training in atomic spectroscopy in a 1997 workshop.

It is also necessary that resources be available. For this study the recent acquisition of the graphite furnace with funds obtained from the college's Bridgewater Foundation was critical. While we often think of resources in terms of laboratory equipment, the more important resource is human. The time of Professors De Ramos and Curry must be made available among all their responsibilities as teachers and department members. In addition, the study depends on the availability of the students who collect the data, prepare and test samples of water and sediment, and contribute in dozens of other ways to the completion of the research.

This project is an excellent example of how academic research can serve a range of interests simultaneously. Not only does it advance knowledge in the purest sense of science, but it also serves as a learning laboratory for students and provides the larger community with information that is critical to its environmental and economic planning. While preliminary results do not show levels of heavy metals that threaten the health of the people who live in the community around the College, these trace elements are, like the tiny insects whose deformities mark the potential for trouble, the "canaries in the mine" that these researchers are the first to examine.